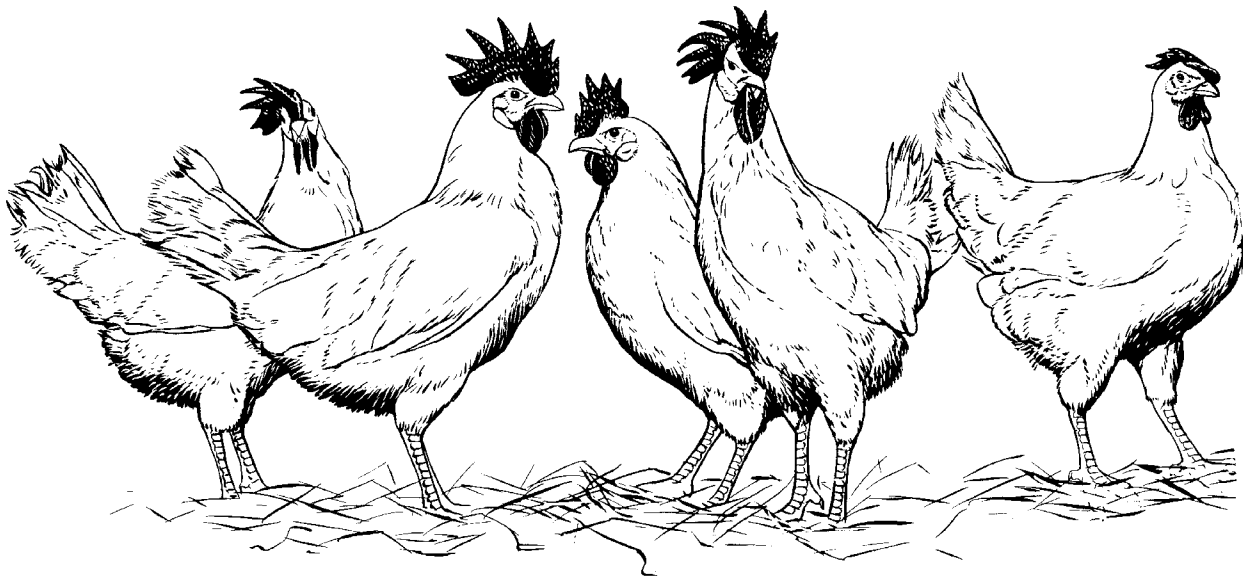


4-H Manual 161
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A decorative arrangement of seven black clover leaves scattered around the title text. One is at the top left, one at the top center, one at the top right, one on the left side, one on the right side, one at the bottom left, and one at the bottom center.

**National 4-H
Avian Bowl Manual**



CLEMSON
COOPERATIVE EXTENSION

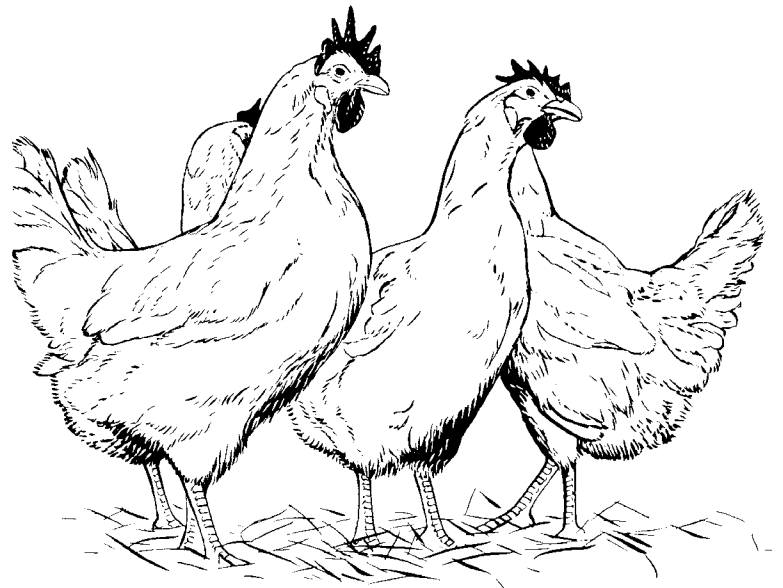
Subject matter to study for Avian Bowl Quiz

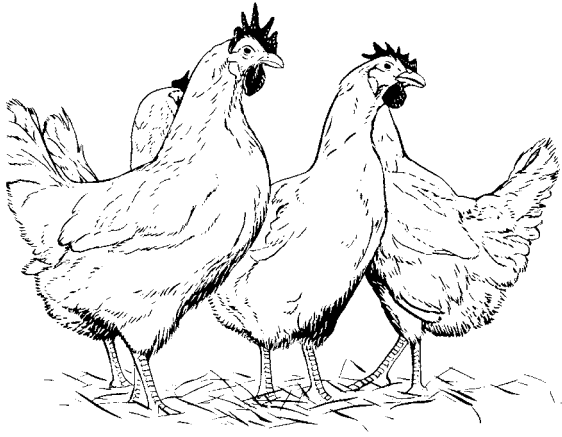
- Avian Systems (Respiratory and Digestive Systems plus The Feather) pgs 41-43
-
- Breeds, varieties, and strains (English, Mediterranean and Continental only) ... pgs 73-78
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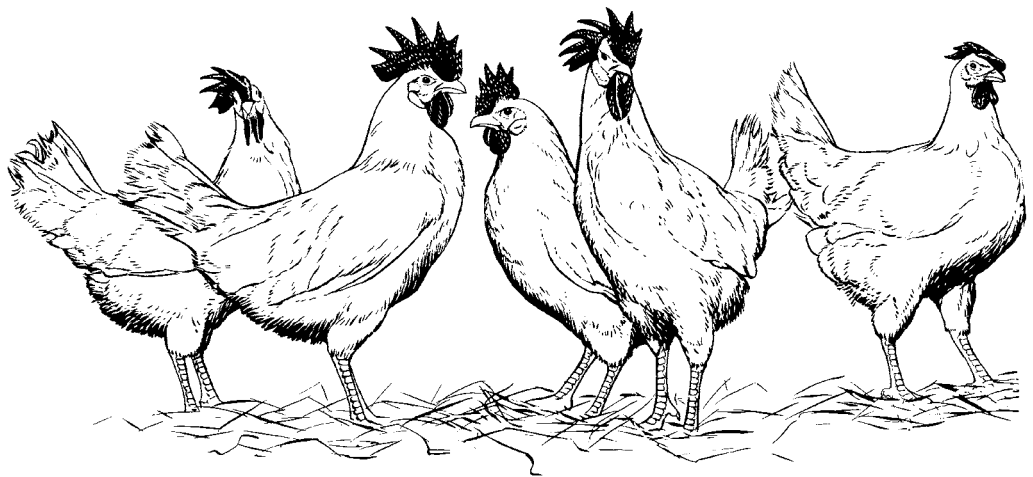
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Compiled and edited by Michelle A. Hall, Professor Emerita,
Animal & Veterinary Science Department, Clemson University





Introduction to Avian Bowl



THE AVIAN BOWL CONTEST

Avian Bowl encourages youth to study the many aspects of avian sciences. The contest was developed in California by Dr. Francine Bradley, Dr. Ralph Ernst, and Mr. John Emo. Avian Bowl was field tested for several years at county fairs, exhibition poultry shows, and 4-H field days. Eventually, the California State Fair became the venue at which the State's champion junior and senior teams were determined. In 1989, Avian Bowl became an official contest at the 4-H Poultry and Egg Conference, held annually in Louisville, Kentucky.

Interest in Avian Bowl grows every year, and the contest has increased the amount and breadth of avian knowledge among participants. The mechanics of play ensure a fast-moving competition that appeals to both contestants and observers.

Purpose of the Contest

1. To encourage youth to expand their knowledge of avian facts and become proficient in poultry management and related subjects.
2. To serve as an award activity and trip for youth who have achieved superior levels of performance in state competition and thus stimulate their learning processes, interest, and enthusiasm.
3. To help youth with career guidance and to promote the poultry industry by stimulating their interest in poultry and other avian species.
4. To make learning fun.

Rules and Information Specific to the Avian Bowl Contest

1. Each state may enter a team of not less than two (2) and not more than four (4) members.
2. There will be a 25-question written quiz given the evening preceding the Avian Bowl Contest. The scores for the top three individuals will be added and averaged to give a team score. This score will be used to establish the seedings for the double-elimination tournament.
3. Questions will be prepared from the National Avian Bowl Study Packet by the Avian Bowl Committee. Ordering information is available from the Clemson University Bulletin Room, Room 95, Poole Agricultural Building, Clemson, SC 29634. The sale price is \$15.00. To order online, please visit: <http://www.clemson.edu/psapublishing>
4. Questions will be fill-in-the-blank (short answer), multiple choice, and spelling.
5. State representatives will be determined by the State 4-H Office or designated representative.
6. Team members may be participants in other contests.
7. As in other contests, team members may only compete one year.
8. The game layout is enclosed.

9. The audience is required at all times to refrain from providing answers to any team member. Disciplinary action for violations will be at the discretion of the Avian Bowl Contest judges.

10. In the event an odd number of teams register, a “bye” will be awarded, as necessary, in order to allow all teams to participate.

11. No flash pictures will be allowed during the contest. No recording of any kind (tape recorders, videos, or written transcription) will be allowed.

1. Officials

A. **Moderator** - Assumes complete direction of the contest, asks all questions, designates contestants to answer questions, and acts as the referee judge. Is at all times IN CHARGE.

B. **Referee Judge** - May rule on the acceptability of any answer.

C. **Time Keeper** - Records total elapsed time for each contest and indicates to the moderator the expiration of total time or the expiration of the time allowed in which to answer questions.

D. **Score Keepers** - Two individuals shall keep scores on each contest. One score should be kept so that all points awarded or taken away in penalties may be checked. The second score is kept to maintain scores visible to the moderator, the contestants, and, in so far as possible, the viewing audience.

2. Types of Questions, Scoring, and Reference Material

A. Questions

1. The degree of difficulty and choice of questions will depend upon the contestants' level of knowledge.
2. Questions may be in the form of written words.

B. Scoring

1. *Number of Questions.* Each set of teams within a round will have the same number of questions. Bonus questions will have the same point value in each game within a round.
2. *Types of Questions.* There are three types of questions:
 - a. Regular Questions.
 - b. Bonus Questions. A bonus question is usually a question requiring a several-part answer or a difficult answer. See point system summary for point values. Bonus questions WILL NOT be passed on to the other team in the event of an incorrect answer. When a team member answers a regular question correctly, a colored card in front of that team member will be turned over by the moderator. Once all members on a team have their cards turned over, that team is entitled to a bonus question. There will only be one bonus question per team per game.
 - c. Tie-breaker Questions. A tie-breaker question is used to replace a question thrown out by the judges. It is also used for the extra questions needed to break a tie between teams.
3. *Tied Games.* In the event that two teams have a tied score in games involving placings, the tie will be broken by asking an additional five (5) questions.

4. Point System

POINTS

Correct Answer-----	5
Incorrect Answer-----	MINUS 5
Acknowledgement Penalty -----	MINUS 5
Bonus Question -----	10

Five (5) points per correct answer on multi-answer questions or bonus value on regular answers. NO loss of points for incorrect answer on bonus questions. The value of the bonus questions will be announced by the moderator before the question is read.

5. *Reference Material.* Competing teams should know well in advance the specific sources from which questions are taken. Questions will be taken from the *National 4-H Avian Bowl Manual, 4-H Manual 161*, from Clemson University. Study sections will be listed in the conference cover letter which accompanies the conference rules.

C. *Mechanics of Play*

1. A double-elimination tournament style format will be followed. Any team which loses two games will be eliminated from the contest. The contest will continue until only one team remains with less than two losses.

2. Pairings, Byes, Order of Play, and Placings

a. The average team score for the written test (lowest score will still be dropped) will be used to determine the seedings for the contest.

b. In the case of two average team written test scores being identical, the seeding will be determined by a coin toss.

c. The contest will be a classic double-elimination contest and will run as such by an individual versed in contest organization.

3. The written scores will not be added in again at the end of the oral competition.

4. The moderator will ask a question. The first person whose light flashes must start to answer the question within *five (5) seconds* after being acknowledged or LOSE five (5) points.

a. Any member answering a question without being acknowledged will LOSE five (5) points.

b. It will be the responsibility of the judges to determine that an answer was started within the five (5) seconds allowed. *It should be noted that repeating the question does not constitute the initiation of an answer.*

c. If an incorrect answer is given, the team will **LOSE** five (5) points.

d. If the question has been completely read, the moderator will not repeat the question, but the other team will have the opportunity to ring in within *five (5) seconds*.

e. Timing will begin when the question is complete and when a signal is activated.

5. When a signal is activated before the question is completely read, the moderator shall stop reading the question, and the contestant has *five (5) seconds* to start the answer based on that portion of the question.

- a. If the answer is correct, the team will receive five (5) points.
 - b. If the answer is incorrect or incomplete, the team will **LOSE** five (5) points.
 - c. If the question was interrupted, the judge may **NOT** ask the contestant to be more specific, expand, or explain in any way his or her answer.
 - d. If an interrupted question is answered incorrectly, the question shall then be completely reread and the other team will have the opportunity to answer it.
6. If neither team can offer an answer to the question within *ten (10) seconds*, the moderator will give the answer, the question will be dropped, and neither team will forfeit points.
7. The **ONLY** discussion allowed between team members will be on **BONUS** questions. *The answers **MUST** come from the team captain.*
- a. Only the number of answers required by the bonus question will be accepted. Example: If the bonus has a four-part answer, the first four answers given by the team captain will be accepted.
 - b. On a bonus question, the team may have *ten (10) seconds* to consult. Time will be called at the end of *ten (10) seconds*, and the captain must start the answer within *five (5) seconds*.
 - c. Once the captain starts the answer, he or she will have *thirty (30) seconds* to complete the answer required.

D. Decisions and Interpretations

Answers and interpretations of questions will be the sole responsibility and final recall of the judge. All decisions of the judge, scorekeepers, and referee-timers are **FINAL**.

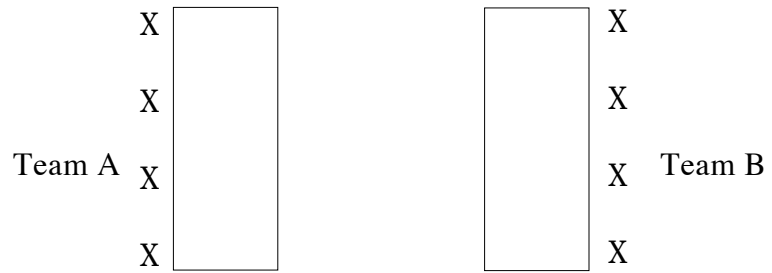
1. A team member will have the privilege to ask the judge to verify an answer that he or she feels is correct.
2. A coach is the only person who can challenge the judge. If a coach challenges the judge's decision, the **COACH** must call "time out" immediately (before the next question is read). A decision made by the judge after the answer is verified will be **FINAL**.
3. Only answers contained in the Avian Bowl Manual will be acceptable to the judge.

Avian Bowl Game Layout

Moderator
X

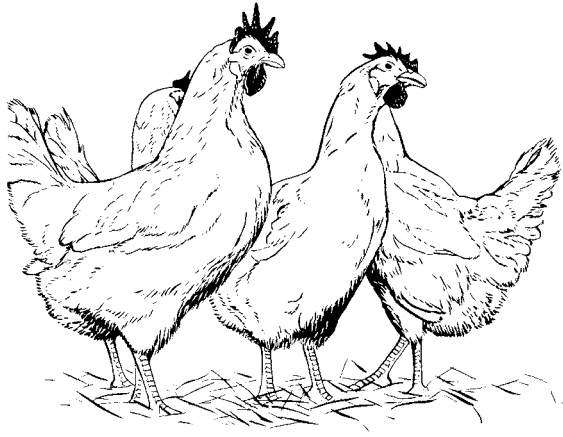
Scorekeeper with
visible score
X

Timekeeper
X

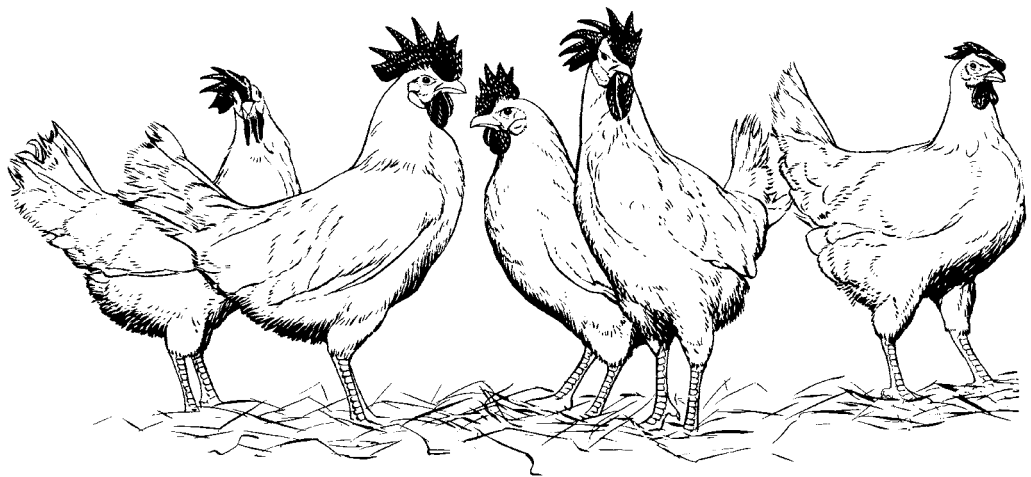


Back-up
Scorekeeper





Poultry Judging



EGG QUALITY

Interior Quality

Candling is used to judge interior egg quality. Although other factors help determine the grade of an egg, the interior quality is most important. Each egg is graded on its individual merits of quality according to United States Department of Agriculture (USDA) grades. The grades are AA, A, B, and Inedible. Knowledge of the parts of the egg is essential to understanding candling and grading (Figure 1).

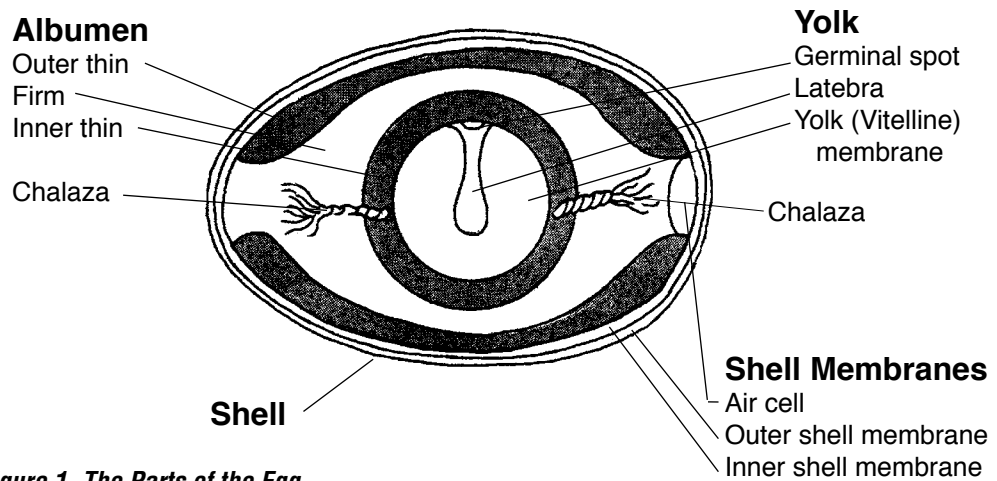


Figure 1. The Parts of the Egg

How to Candle

Hold the egg up to the candling light in a slanting position. You can see the air cell, the yolk, and the white. The air cell is nearly always in the large end of the egg. Therefore, put the large end next to the candling light.

Hold the egg between your thumb and first two fingers. Then by turning your wrist quickly, you can cause the inside of the egg to whirl. This will tell you a great deal about the yolk and white. When you are learning to candle, you will find it helpful to break out and observe any egg contents you are in doubt about.

Application of Standards

Use the specifications given in Table 1 to determine the grade of an egg by candling. Consider air cell depth, yolk outline, and albumen quality.

Table 1. Summary of Standards for Interior Quality of Eggs by Candling for 4-H Poultry Judging

Quality Factor	AA Quality	A Quality	B Quality	Inedible
Air Cell	1/8" or less in depth	3/16" or less in depth	More than 3/16" in depth	Does not apply
White	Clear Firm	Clear May be reasonably firm	Clear May be weak and watery	Does not apply
Yolk	Outline slightly defined	Outline may be fairly well-defined	Outline clearly visible	Does not apply
Spots (Blood or meat)	None	None	Blood or meat spots aggregating not more than 1/8" in diameter	Blood or meat spots aggregating more than 1/8" in diameter

Air Cell Depth

The depth of the air cell is the distance from its top to its bottom when the egg is held with the air cell up (Figure 2). In a fresh egg, the air cell is small, not more than an eighth of an inch deep. As the egg ages, evaporation takes place and the air cell becomes larger and the egg is downgraded.

Measuring Air Cell Depth

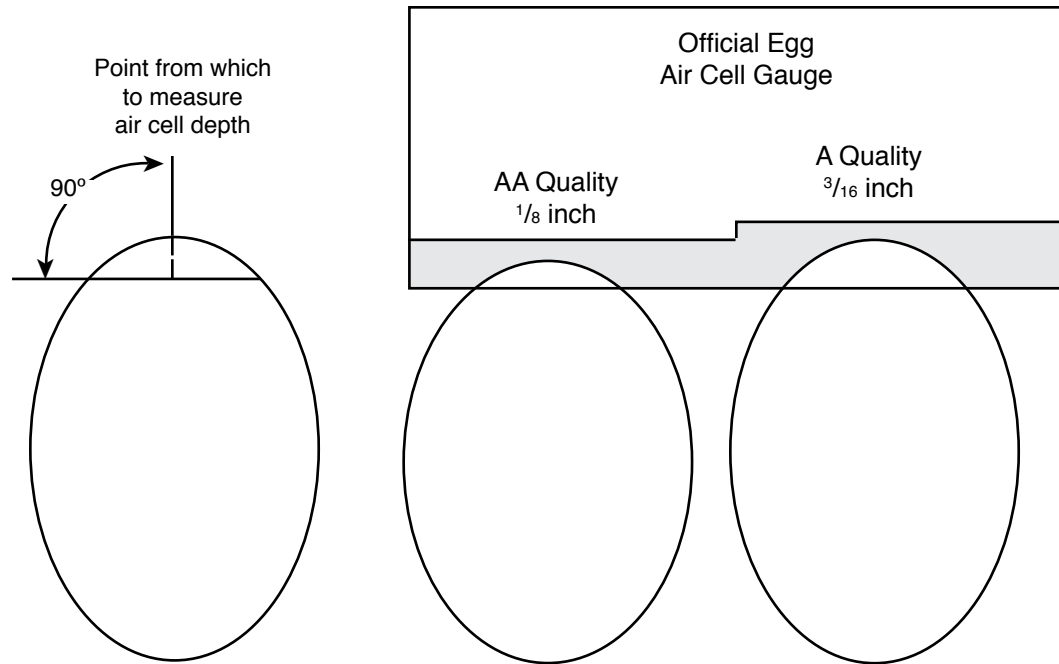


Figure 2. Gauge for Measuring Depth of Air Cell

Yolk

The yolk of a fresh, high-quality egg will be surrounded by a rather dense layer of albumen or white. Therefore, it moves only slightly away from the center of the egg when it is twirled before the candler. Because of this, yolk outline is only slightly defined or partially visible. As the egg ages or deteriorates in quality, the albumen thins and the yolk tends to move more freely and more closely approaches the shell. The yolk then becomes more visible when candled.

White or Albumen

The character and condition of the white or albumen is determined largely by the behavior of the yolk of the egg when the egg is candled. If the yolk retains its position in the center when the egg is twirled, the white is usually firm and thick.

Eggs with blood or meat spots more than $\frac{1}{8}$ inch in diameter should be classified as Inedible. However, very small pinpoint spots should not be used in judging contests. Contestants should not confuse blood spots with the chalazae. This string of albumen helps hold the yolk in the center of the egg and may be prominent in some eggs. The chalazae are distinguished from a blood spot by a bright area of refracted light that accompanies the darker shadow of chalazae.

The following will not be considered as quality factors when candling eggs for interior quality.

- Loose, bubbly, or out-of-position air cell
- Exterior stains or dirt
- Faulty egg shell shape or texture

Exterior Quality

In commercial egg processing plants, eggs are graded simultaneously for exterior and interior quality. However, in judging contests, it is necessary to grade eggs for exterior quality separately, because handling of eggs by contestants can change the grade. Exterior quality standards reduce the number of eggs with defects that detract from the appearance of the egg or that would have a low probability of surviving the rigors of handling in normal market channels. In other words, we want the consumer to have clean, unbroken eggs with practically normal shape and texture. Contestants should not be too harsh in assigning grade to eggs that may have minor defects. This is especially important when judges have gained experience in evaluating eggs with various degrees of abnormalities.

Exterior Quality Grades

Table 2 summarizes the descriptive terminology used in the *USDA Egg Grading Manual* to help determine the grade of an egg by exterior quality. For 4-H Poultry Judging Contests, eggs will be assigned the grades of A, B, and Dirty. Grades AA and A have identical standards. The factors that affect exterior quality are discussed below.

Stains

Grade A eggs must be clean. These eggs can show traces of processing oil (used to preserve freshness). This processing oil may give a shiny or opaque appearance. Eggs with slight stains or moderate stains covering less than $\frac{1}{32}$ of the shell—if the stain occurs in one localized area—or $\frac{1}{16}$ of the shell surface—if the stains are scattered—are assigned Grade B.

Dirty eggs have prominent stains, or moderate stains covering more than $\frac{1}{32}$ of the shell if localized, and $\frac{1}{16}$ of the shell if scattered. Eggs with adhering dirt or foreign material are also classified as Dirty.

Contestants will be evaluating only the exposed surface of the egg. The underside of the egg should be considered free from defects. Evaluate only what you see.

Table 2. Summary of Standards for Exterior Quality of Eggs

Factor	Grade		
	AA or A	B	Dirty
Stain	Clean. May show small specks, stains, or cage marks that do not detract from general clean appearance of the egg. May show traces of processing oil.	Slight stains, moderate localized stains less than $\frac{1}{32}$ of shell, or scattered stains less than $\frac{1}{16}$ of shell.	Prominent stains. Moderate stains covering more than $\frac{1}{32}$ if localized and $\frac{1}{16}$ of the shell if scattered.
Adhering Dirt or Foreign Material	NONE	NONE	Adhering dirt or foreign material (1.0 mm in area or greater).
Egg Shape	Approximately the usual shape.	Unusually or decidedly misshapen (very long or distorted).	
Shell Texture	May have rough areas and small calcium deposits that do not materially affect shape or strength.	Extremely rough areas that may be faulty in soundness or strength. May have large calcium deposits.	
Ridges	Slight ridges that do not materially affect shape or strength.	May have pronounced ridges.	
Shell Thickness	Free from thin spots.	May show pronounced thin spots.	

Adhering Dirt or Foreign Material

Grade A and B eggs cannot have any adhering dirt or foreign material. Eggs with adhering material (three-dimensional) larger than a speck (about 1.0 millimeter) should be classified as Dirty. Small specks of dust or lint that may have settled out of the air should not be considered.

Egg Shape

There is a considerable range of egg shapes that could be considered “approximately the usual shape” or Grade A. Eggs that are perfectly spherical (round) or too long to fit in the egg carton should be graded B quality. B quality grade for egg shape will include eggs that are clearly misshapen or that have definite flat areas.

Shell Texture

Eggs with faulty texture are much weaker in shell strength and may be broken during distribution. Shells with large calcium deposits (greater than an eighth of an inch in diameter) should be classified as Grade B. Eggs with small calcium deposits are classified as Grade A. There is no standard for the number of calcium deposits, which means that small calcium deposits over the entire shell may be classified as Grade A if otherwise qualified. A good rule of thumb is that if you were to pull your fingernail across a calcium deposit, and there would be a good size hole if it came off, the egg would be classified as Grade B.

Ridges

Ridges can result in weakened shells. Many eggs show small ridges and most of these should be classified as Grade A. Those eggs with large ridges are Grade B.

Shell Thickness

The shell should appear thick enough to withstand reasonable handling without breaking. Grade A eggs must have thick shells with no thin spots. Thin shells or thin spots would place an egg in Grade B. In all cases the shell must not be broken.

Broken-Out Quality

Eggs broken out for this class will be Grades AA, A, B, and Inedible. Eggs with spots (blood and meat) more than an eighth of an inch in diameter will be classified as Inedible. Eggs with spots less than an eighth of an inch in diameter will be classified as Grade B.

The only other criteria that should be used to grade broken-out eggs is the height of the thick albumen relative to the size of the egg. The size, flatness, or position of the yolk should not be considered. Broken-out grade determination must be based on “U.S. Standards for Quality of Shell Eggs” from the USDA. The thick albumen retains the shape of the egg in a Grade AA and is thick, whereas there is a flattening and rounding of edges in a Grade A egg. The thick white in a Grade B egg is flat and barely visible.

READY-TO-COOK POULTRY

Carcasses are graded A, B, or C quality. Factors used in judging ready-to-cook carcasses in a 4-H Poultry Judging Contest are:

- exposed flesh,
- broken and disjointed bones, and
- missing parts.

Always mark your scorecard for the lowest grade defect found on the carcass.

Because of the length of most judging contests, carcasses will dry out. You should not place carcasses based on off-color areas such as bruised, dried out, or brown areas. In addition, feathers and pinfeathers are not used as a quality factor in ready-to-cook carcass judging.

Carcasses used for contests will usually have Grade A fleshing, conformation, and fat cover. You should, however, be prepared to recognize poor fleshing and finish if such birds are available for a contest.

The carcasses you judge will be hanging from shackles. This method is used so it is easier to see all parts of the bird. **CARCASSES CANNOT BE TOUCHED OR HANDLED DURING JUDGING.** It is permissible to turn the shackle to see the whole bird as long as you do not touch the carcass. If the ready-to-cook carcasses are on plates, judge them as you see them.

Ready-to-cook poultry will be judged according to the quality specifications in Table 3. There are four weight categories for determining the size of cuts or tears on the different parts. There are no weight ranges for missing parts and disjointed and broken bones. Learn a method of judging carcasses by looking at one part at a time.

Cuts, Tears, and Trims

Cuts, tears, and trims result from a miscut with a knife or tearing of the skin during a processing operation. When ready-to-cook poultry is downgraded for cuts, tears, and trims it is based on the weight of the carcass and the part. The length of a cut or the amount of flesh showing on the part determines the grade.

REMEMBER: Cuts, tears, or trims must be completely through the skin so that the meat, called flesh, can be seen, in order to put the carcass in a lower grade.

The grade is determined by the amount of exposed flesh as length of cut or amount of skin missing (Table 3). Sometimes there may be more than one cut, tear, or trim on a particular part; add the length, or amount missing, to determine the grade based on that part only. Each part is graded separately and the grade is determined by the part having the lowest grade on that carcass. Exposed flesh from the continuation of an evisceration cut at the front and back of the breast should not be considered in determining carcass grade.

The Grade A carcass is not permitted to have any cuts, tears, or missing skin. The Grade B carcass can have up to a third of the flesh showing as long as meat yield is not materially affected. The Grade C carcass has more than a third of the flesh showing.

A good rule of thumb is that the trim is a slight trim if it does not exceed the thickness of a five-cent piece (nickel) or an eighth of an inch. An excessive trim that would move the grade lower would have the appearance of a cupped effect that looks deeper than an eighth of an inch.

Refer to Table 3 for the section on cuts and tears for the lengths and amount of exposed flesh that is allowed. Remember: A slight cut into the meat not more than the thickness of a nickel (an eighth of an inch)—so that the appearance of the part does not look bad—is permitted in Grade B. If the trim into the meat is more than the width of a nickel (an eighth of an inch) or the trim appreciably alters the appearance of the meat, then it is a Grade C.

Missing Parts

Missing parts to be considered in judging are the wings, tail, and part of the back area if it is no wider than the base of the tail. It is important to remember that the weight of the carcass does not count in judging for missing parts.

The Grade A carcass may have the wing tips and tail missing where the tail joins the back. The Grade B carcass may be missing the wing up to the second joint, as well as the tail and back less than halfway to the hips. In a Grade C ready-to-cook carcass the wing may be cut off at the third joint at the juncture of the body. In addition, the tail and back, more than halfway to the hip, may be missing. For missing parts, use the lowest grade that you see for wings, tail, and back.

Disjointed and Broken Bones

A disjointed bone is where the joint is out of the socket. In other words, the part that is disjointed is still whole and not broken. You will be able to see the end, or knobby part of the joint underneath the skin.

Broken bones occur between the ends of the bone. They can be broken so that the bone either does not come through the skin or the bone penetrates the skin. When the broken bone does not come through the skin it is called nonprotruding. When the bone penetrates the skin, it is called protruding. As shown in Table 3, a Grade A ready-to-cook carcass can have one disjointed, but no broken bones. A Grade B carcass can have either two disjointed or one disjointed and one nonprotruding broken bone. More than two disjointed and/or one or more broken, protruding bones, make the carcass Grade C.

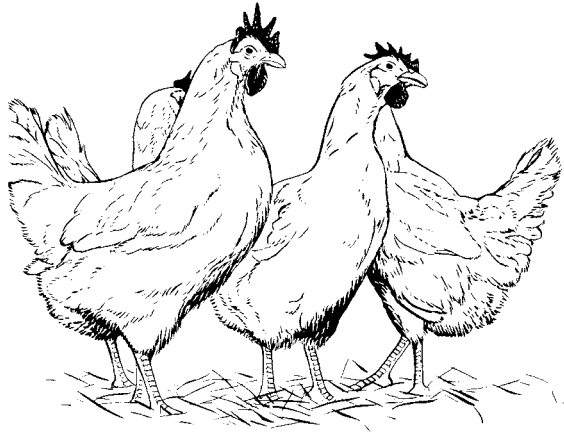
Table 3. Summary of Poultry Judging Contest Specifications of Quality for Individual Carcasses of Ready-to-Cook Poultry

Factor		A Quality		B Quality		C Quality
Exposed Flesh¹ Carcass Weight		Breast ² & Legs	Else- where	Breast & Legs	Else- where	No Limit
Minimum	Maximum					
None	2 lbs	None	3/4"	1/3 of flesh exposed		
Over 2 lbs	6 lbs	None	1 1/2"	on each part of		
Over 6 lbs	16 lbs	None	2"	carcass provided		
Over 16 lbs	None	None	3"	meat yield not ap- preciably affected		
Disjointed bones		One disjointed		Two disjointed and no broken or one disjointed and one nonprotruding broken		No Limit
Broken bones		None				No Limit
Missing parts		Wing tips and/or tail removed at the base		Wing(s) to second joint Back area not wider than base of tail and extend- ing halfway between base of tail and hip joints.		Entire wing(s) Back area not wider than base of tail extending to area between hip joints

¹Longest length for a cut and total area for tears and missing skin based on the whole part.

²For purposes of definition, the parts of the carcass shall be each wing, leg, entire breast, and entire back.

Acknowledgments: National 4-H Poultry and Egg Conference Extension Committee — Dan E. Bigbee, University of Nebraska-Lincoln; Joyce Jones, Virginia Polytechnic Institute and State University; Charles Wabeck - Chairman, University of Maryland



Understanding the Food Poisoners

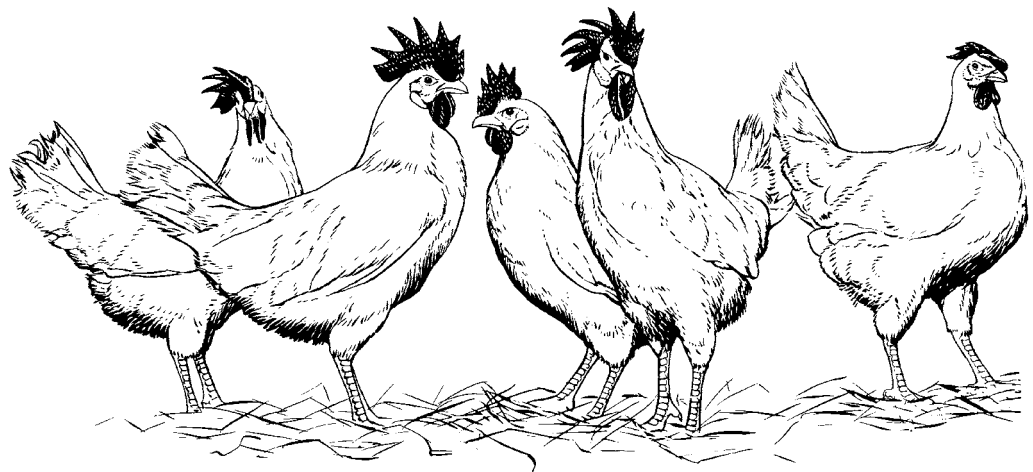


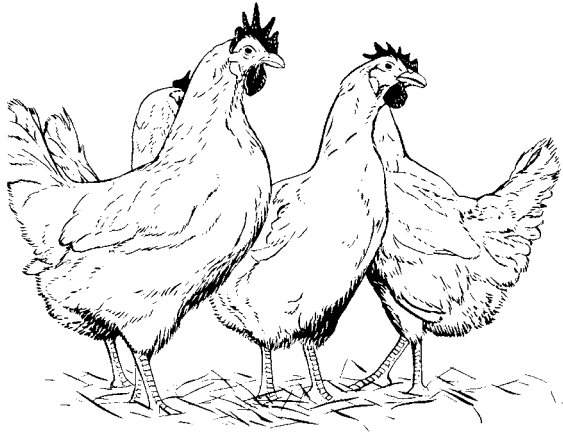
Table 4. Understanding the Food Poisoners

What is food poisoning? Food poisoning, caused by harmful bacteria, normally produces intestinal flu-like symptoms lasting a few hours to several days. But in cases of botulism or when food poisoning strikes infants, the ill, or the elderly, the situation can be serious.

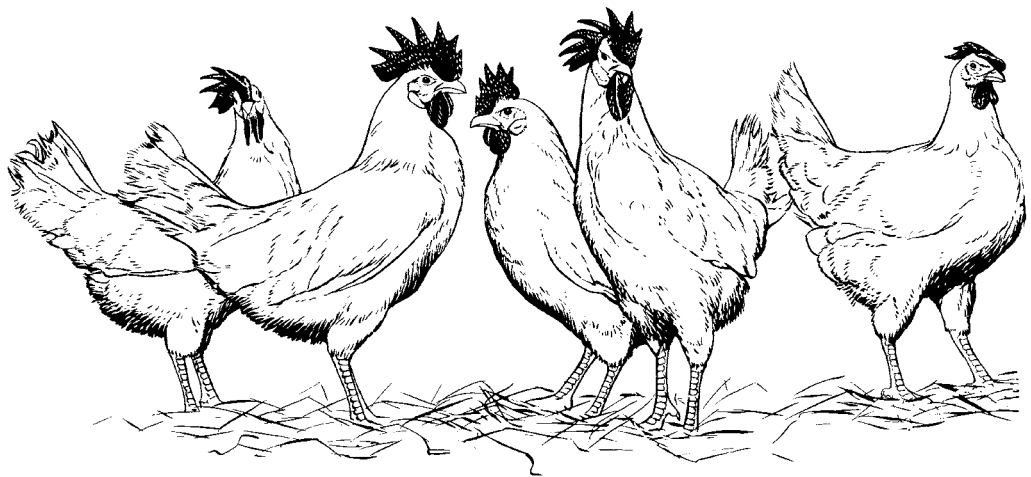
Where do these bacteria come from and how can they be stopped? Food poisoning bacteria, microscopic in size, surround us—in the air, soil, and water, in our own digestive tracts, and in those of many animals. The only way they can effectively be stopped is by careful attention to food handling rules like those outlined below.

BACTERIA	HOW IT ATTACKS	SYMPTOMS	PREVENTION
Staphylococcus aureus (Staph)	Staph spreads from someone handling food. It is found on the skin and in boils, pimples, and throat infections. At warm temperatures, staph produces a poison.	2 to 8 hours after eating, you could have vomiting and diarrhea lasting a day or two.	Cooking won't destroy the staph poison so: -Wash hands and utensils before preparing food. -Don't leave food out over 2 hours. Susceptible foods are meat, poultry, meat and poultry salads, cheese, egg products, starchy salads (potato, macaroni, pasta, and tuna), custards, and cream-filled desserts.
Salmonella	You can get salmonella when infected food—such as meat, poultry, eggs, or fish—is eaten raw or undercooked. Other causes include cooked food coming into contact with infected raw food or an infected person contaminating food.	In 12 to 36 hours you could have diarrhea, fever, and vomiting lasting 2 to 7 days.	Keep raw food away from cooked food and: -Thoroughly cook meat, poultry, and fish. -Be especially careful with poultry, pork, roast beef, and hamburger. -Don't drink unpasteurized milk.
Clostridium perfringens	This "buffet germ" grows rapidly in large portions of food that are cooling slowly. It can also grow in chafing dishes which may not keep food sufficiently hot and even in the refrigerator if food is stored in large portions which do not cool quickly.	In 8 to 24 hours you could have diarrhea and gas pains, ending usually in less than a day. But older people and ulcer patients can be badly affected.	Keep food hot (over 140°F) or cold (under 40°F) and: -Divide bulk cooked foods into smaller portions for serving and cooling. -Be careful with poultry, gravy, stews, and casseroles.
Campylobacter jejuni	You drink untreated water on an outing. Your pet becomes infected and spreads it to the whole family, or you eat raw or undercooked meat, poultry, or shellfish.	In 2 to 5 days you could have severe (possibly bloody) diarrhea, cramping, fever, and headache lasting 2 to 7 days.	Don't drink untreated water or unpasteurized milk and: -Thoroughly clean hands, utensils, and surfaces that touch raw meats. -Thoroughly cook meat, poultry, and fish.
Clostridium botulinum	Often occurs in home-canned or any canned goods showing warning signs—clear liquids turned milky, cracked jars, loose lids, swollen or dented cans or lids. Beware of any jar or can that spurts liquid or has an off-odor when opened.	In 12 to 48 hours your nervous system could be affected. Other symptoms include double vision, droopy eyelids, and difficulty speaking, swallowing, or breathing. Untreated botulism can be fatal.	Carefully examine home-canned goods before use, and: -Don't use any canned goods showing danger signs. -If you or a family member has botulism symptoms, get medical help immediately. Then call health authorities.

Note: While the chart highlights the preventive measures most important in avoiding each type of bacteria, you should understand that all the rules of prevention should be followed with all food.



Raising Waterfowl



RAISING WATERFOWL

Ducks and geese are popular farm animals. The unique personalities of these birds add to their appearance. Ducks and geese easily become attached to humans and make great pets. They are relatively easy to raise and require minimum attention and simple equipment and housing. Even the fancy purebred varieties of waterfowl produce very nice carcasses.

Table 5. Duck Breeds

There are 14 “standard” breeds of ducks which are divided into 4 classes: heavy, medium, light, and bantam. Table 5 categorizes the breeds of ducks into the various classes and gives additional information on the different breeds.

Class	Breed	Variety/Color	Standard Adult Live Weight (Lb)	Average No. Eggs Per Year	Fly	Generally Recognized Purpose	Special Distinguishing Features
Heavy	Aylesbury	White	8-9	40-60	No	Meat	White skin and bill, large deep keel
	Muscovy (Pato)	White, Blue Chocolate, Colored	9-12 (males) 5-7 (females)	60-120	Yes	Meat/Eggs	White skin and bill, red warty face, males much larger than females, quite voiceless hiss
	Pekin	White	8-9	100-180	No	Meat/Eggs	Yellow skin and feet; orange bill
Medium	Rouen	Gray**	8-9	40-60	No	Meat/Ornamental	Yellow skin, large deep keel
	Buff	Buff	7-8	60-100	No	Meat/Ornamental	Buff plumage
	Cayuga	Black	7-8	60-100	No	Ornamental	Beetle-green sheen
	Crested	Black, White	7-8	60-100	No	Ornamental	Ball of feathers on back of head
	Swedish	Blue	7-8	60-100	No	Ornamental	Blue plumage with white breast
	Campbell	Khaki	4-5	200-300	No	Eggs	Seal-brown plumage
Light	Magpie	Black and White, Blue and White	3-4	30-60	No	Ornamental	
	Runner	Black, Buff, Chocolate, White, Cumberland Blue, Fawn and White, Pencilled, Gray**	3-4	100-150	No	Eggs/Ornamental	Unique upright carriage resembles a walking bottle
Bantam	Call	Blue, Gray,** Snowy White	1 $\frac{1}{2}$ -2	20-50	Yes	Ornamental	Small, round heads and bodies; loud calling sound from females
	East India	Black	2-3	20-50	Yes	Ornamental	Beetle-green sheen
	Mallard	Gray	3-4	20-50	Yes	Ornamental	Resembles common wild mallard

**Gray color pattern same as wild mallard

Table 6. Geese Breeds

There are 11 "standard" breeds of geese which are divided into 3 classes: heavy, medium, and light. Table 6 shows the classes and characteristics of the different breeds.

Class	Breed	Variety/Color	Standard Adult Live Weight (Lb)	Average No. Eggs Per Year*	Fly	Generally Recognized Purpose	Special Distinguishing Features
Heavy	Toulouse	Gray, Buff	20-26	20-50	No	Ornamental	Massive, loose feathered, large dewlap
	Embden	White	20-26	40-60	No	Meat	Blue eyed, large white geese
	African	Brown	18-20	30-50	May	Meat/Ornamental	Knob at base of upper bill, distinctly dew-lapped
Medium	Sebastopol	White	12-14	20-40	No	Ornamental	Reverse curling to body feathers
	Pilgrim	Sex-linked	13-14	20-40	May	Meat	Males white, females gray
	American Buff	Buff	16-18	20-40	May	Meat/Ornamental	
	Saddleback Pomeranian	Gray, Buff	14-16	20-40	No	Meat/Ornamental	Half of neck colored; back colored, giving the appearance of a saddle
	Chinese	White, Brown	10-12	60-100	May	Meat/Eggs Ornamental	Noisy, large knob at base of upper bill, long slender neck
Light	Tufted Roman	White	8-10	20-40	May	Ornamental	Tuft of feathers on head
	Canada	Common	10-12	10-20	Yes	Meat/Ornamental	Like common wild goose
	Egyptian	Colored	4-6	10-20	Yes	Ornamental	Appear to have iridescent plumage, black patch around eyes

*If maintained under commercial management conditions

SOURCES

Where you obtain your stock depends on why you are raising ducks or geese. Those raised for meat may be purchased from a commercial hatchery or local feed mill. Purchase breeding and exhibition stock from established breeders. Commercial hatcheries do not normally deal in quality exhibition stock. Check local or state fanciers' clubs, shows, or poultry publications for the names and locations of breeders of purebred waterfowl.

It is usually better to buy stock from a local breeder instead of ordering stock through the mail, since you can see how birds are raised, observe their health, and ask questions. Shipping is costly and stresses the animals.

Inexperienced persons should not buy breeding stock at swap or trade days even though you might attend these events to learn what birds are available. Try to deal with breeders at their place of business.

The number of birds to buy depends on several factors, including available time, facilities, and finances. It is better to raise a few well-cared for birds than to burden yourself with too many mediocre, overcrowded birds. Additional birds may be purchased or raised as you gain experience.

BROODING AND REARING DUCKLINGS AND GOSLINGS

Artificial Brooding

Ducklings and goslings can be brooded much like baby chicks. Waterfowl require more floor and feeder space due to their rapid growth and need heat for a much shorter time than chicks.

Brooding House

Domestic waterfowl do not require special brooding facilities. The brooder system must keep young birds dry and clean and provide plenty of fresh air (without drafts). A concrete, wood, dirt, or gravel floor is satisfactory if covered with a thick layer of litter. Crushed corn-cobs, wood shavings, sawdust, straw, or other commercial litters are satisfactory. Do not use fine litter until waterfowl learn to distinguish it from their feed. Otherwise, excessive litter consumption can result in death. The litter should be changed when wet or dirty. Be sure litter is free of molds.

Use small-mesh wire (approximately $\frac{3}{8}$ -inch) if young waterfowl are raised on wire. Do not raise bantam ducks or other small-legged waterfowl on wire as their hocks often drop through the mesh and become trapped. Cover the wire or litter with an old burlap bag or rags for the first week. To prevent leg injuries, do not use newspaper or any other slippery surface.

Floor Space

Ducks and geese need plenty of room to grow. Crowding slows growth and increases mortality. Allow one-half a square foot per bird for the first 2 weeks. Double the space provided every 2 weeks until 4 square feet per duck and 6 square feet per goose are available, or until birds are placed outside.

Heating

The proper temperature must be maintained in a draft-free pen. The temperature should be 90 °F (at back height) during the first week. Determine the temperature at about 3 inches above the litter for ducks and 6 inches above the litter for goslings.

Place young birds under the heat source when they are first placed in the brooder. After 10 days reduce the temperature 5 °F per week down to 70 °F. During extremely cold weather reduce the temperature gradually, since any drastic changes in temperature may shock or stress birds.

Birds over 6 weeks of age do not usually require heat since most waterfowl are fairly well-feathered and can care for themselves on outside range by that time.

Good managers observe their birds closely. Once young birds learn the locations of heat, they will move to an area where they feel comfortable. Birds huddled tightly together directly under the heat source are too cool; those crowded near the outer areas of the pen are too warm.

In floor pens, place a 12-inch-high cardboard or hinged wood circle 3 to 4 feet from the edge of the heat source to prevent drafts, prevent birds from huddling in cold corners, and keep them near the heat for the first week. Remove the guard after a week.

Feeding and Watering

Always provide convenient access to feed and water in the brooder. Chicken equipment (feeders and waterers) can be used if openings are large enough for waterfowl heads. Increase trough space frequently to avoid crowding as the birds grow.

Give young waterfowl only unmedicated feeds to avoid possible adverse reactions. Use starter mash formulated specifically for waterfowl, if available.

Commercial starter, grower, and breeder diets for waterfowl are usually available from local feed mills. Pelleted feeds are usually best even though they cost slightly more than mash feeds. Waterfowl tend to waste feed, especially when it is finely ground.

Feed a starter ration during the first 3 weeks and then change to a grower. Birds 3 weeks of age can be fed small leafy greens or allowed on limited range. To prevent digestive problems, feed some grit a week before allowing access to green plants. Table 7 and Table 8 show nutrients recommended at different ages.

Table 7. Nutrients Recommended for Ducks

Nutrient	0-3 weeks Starter	After 3 weeks Grower	Breeder
Metabolizable energy (cal/lb)	1350	1400	1300
Protein %	22	16	15
Calcium %	0.6	0.6	2.75
Phosphorus %	0.6	0.6	0.6

Table 8. Nutrients Recommended for Geese

Nutrient	0-6 weeks Starter	After 6 weeks Grower	Breeder
Metabolizable energy (cal/lb)	1350	1350	1300
Protein %	22	15	15
Calcium %	0.8	0.6	2.25
Phosphorus %	0.6	0.4	0.6

Dip the bills of some birds in water to help them find the water. **Provide plenty of fresh water at all times.** Water is essential to keep waterfowl growing and healthy. Make sure young ducks and geese cannot get into the waterers. The drinking area should be large enough for birds to dip their heads into the water (at least as deep as their eyes).

After 2 weeks, place the waterer on wire-covered stands 4 inches high to help keep litter dry. Locate the waterers some distance from the feeding area to prevent birds from transferring feed directly into the waterers.

Keep Young Waterfowl Dry

Do not let young waterfowl swim or become excessively wet for the first 3 weeks. Young birds that become wet chill easily, tend to crowd, and may flip onto their backs resulting in death.

HANDLING GEESE AND DUCKS

To catch ducks and geese, slowly walk them into a small area or corner. Do not chase them. Never catch or carry them by the legs since their weak legs are easily disjointed or broken.

Catch waterfowl by placing one hand firmly around the neck near the body. Then place the other hand on the bird's back over the wings. Release the neck and gently slide the palm of your hand under the breast and abdomen, so the bird's weight is supported on your forearm. Lift birds under your arm and hold their legs gently between your fingers to prevent them from scratching. Hold wings to prevent flapping. Medium and light waterfowl can be carried for short distances by grasping the wings near the body, but larger, heavier ducks or geese should not be carried in this manner.

SEXING WATERFOWL

Visual Sexing

Ducks are easier to sex than geese. Male ducks usually have so-called "drake feathers" which curl forward from the top of their tails. Female ducks lack these feathers. The call of mature males is soft and hoarse; females make a loud, distinct quacking sound.

Sexually mature gray (mallard-colored) drakes have green iridescent feathering on their heads which is lost during the eclipse phase of the molt in the summer. Females with gray color pattern have penciled feathers throughout their bodies.

Female and male Muscovy ducks have identical plumage. The males lack curled drake feathers. Neither sex has a pronounced voice. The sexually mature males show more and larger caruncles and their bodies are twice as large as females. (Caruncles are the red, fleshy, wart-like tissues around the eyes.)

There are few differences in the voice or plumage of male and female geese. Male Pilgrim geese have white plumage and females have grey and white plumage. Among breeds with knobs on the head, such as the Chinese and Africans, males' knobs are usually much larger.

Vent Sexing

Vent sexing is usually the most reliable method to sex geese. This method may also be used for ducks.

Turn the bird on its back, preferably over a knee or table top, and place its tail back over the edge. Then place your hands on both sides of the vent and push against the sides of the vent with thumbs while your fingers press the tail back. Apply some pressure directly below and on the sides of the vent to invert or expose the extremities of the sex organ.

The male organ in some birds is somewhat difficult to unsheathe. A bird may be a male even if no corkscrew-like male organ appears after applying slight pressure. Only the presence of a female genital eminence (rosette) positively indicates that a bird is a female.

SELECTING AND PREPARING BIRDS FOR MARKET

Some people raise ducks and geese only for meat. Yet exhibition and breeding waterfowl must also be culled to remove excess and undesirable birds. These culls are usually edible and can also be marketed as meat birds.

Marketing for Food

Young ducks are usually marketed at 7 to 8 weeks of age when they weigh about 4 pounds. Young geese can be sold at 6 to 12 pounds (15 to 20 weeks of age) or at 5 to 7 pounds (10 weeks of age). Be sure you accurately indicate the weight, age, and class of poultry you sell.

Most surplus waterfowl can be marketed by advertising in local papers or shopping guides. Ducks and geese may be sold live or dressed. The owner usually will either slaughter and dress them or have them custom processed. Those who market many birds usually sell them to a waterfowl processing plant.

Waterfowl can be killed, dressed, and picked like other types of poultry. They are harder to pick than chickens, but are easier to pick at certain times. Catch a few birds a week before you plan to slaughter and pull out a tail feather and a few breast feathers. If the tips show signs of blood or are very soft and flexible, wait another 7 to 10 days before slaughter. Feathers with hard tips which are easy to remove indicate that birds should be slaughtered as soon as possible. Birds usually pick better in fall after their feathers mature.

Provide water but do not feed birds 10 to 18 hours before slaughter. Withholding feed helps prevent contamination during slaughter. Handle birds carefully before slaughter to avoid bruising the flesh. The appearance of dressed carcass is extremely important. The breast and legs should be fully developed and free from defects.

Dressed birds may be sold fresh or frozen. Place dressed birds in closed, moisture-proof bags to prevent discoloration and dehydration. Refrigerate fresh-dressed birds below 40 °F for no longer than 5 days.

Marketing Breeding Stock

Breeders of good-quality stock frequently exhibit their birds at shows. Contacts made there often lead to sales. Others depend on word of mouth, reputation, customers, successes, and advertising to sell their quality stock. Clubs also sponsor sale days or swap meets. Consider advertising in poultry publications, newsletters, and local newspapers.

SELECTING AND MANAGING BREEDER FLOCKS

Waterfowl selected for breeding stock should show vigor and good size for their breed. Good breeding stock have well-placed and strong legs, proper carriage, adequate body depth and width, smooth feathers, and exhibit free and easy movement. Keep additional males and females to allow for further culling, mortality, and injuries.

Breeders for market flocks should be selected when birds reach market age. Make the final selection when birds reach sexual maturity. Potential breeders for exhibition flocks should be culled for poor traits after they reach sexual maturity. Exhibition birds should show the breed characteristics illustrated in the American Poultry Association's *Standard of Perfection*.

General Breeding Management

Drakes will readily mate with almost any female. One vigorous drake can service five to six females.

Most breeds of geese mate in pairs or trios, although ganders of some light breeds will mate with as many as five females. Canada geese usually mate in pairs and mate for life. Most ganders of other breeds also tend to prefer a particular mate.

Any well-lighted, well-ventilated, draft-free, and dry shelter is satisfactory for breeding waterfowl. Provide convenient access to the outside yard since waterfowl prefer to be outdoors during the day, even during cold weather.

Dry, clean litter helps eggs stay clean, and also prevents birds' feet from getting damp and freezing during winter. Provide 4 to 5 square feet of floor space for each breeding duck and 5 to 6 square feet for each goose.

Provide at least one nest for every four to five laying females. Nests are easy to build. Duck nests can be made by constructing 12- to 14-inch partitions every 12 inches along a 6-foot board (back). Nail a 2-inch board along the lower front. Place the nests against a wall and add straw or shavings to encourage the birds to lay in the nests. Similar nests for geese should be proportionately larger. A barrel open on one end is also satisfactory. Block the sides so the barrel cannot roll. Ducks and geese like to cover their eggs with bedding. Gather eggs daily to encourage continued laying and delay broodiness.

Waterfowl normally start laying eggs in late February. Egg production usually peaks in April and declines rapidly during June. Ducks lay more consistently and over a more sustained period than geese.

To bring mature waterfowl into production during fall and winter, gradually increase the length of the lighted period to 14 to 16 hours daily. Supply light 3 to 4 weeks before desired start of egg production. The males must be placed under light 2 weeks before the females.

Provide grit to breeders at all times. Limestone or oystershell should also be available before and during egg production.

INCUBATION

The incubation period for waterfowl eggs varies.

Most ducks	28 days
Muscovy (ducks)	35 days
Most geese	30 days
Canada and Egyptian geese	35 days

Since waterfowl tend to lay eggs early in the mornings, collect eggs from 6 a.m. to 9 a.m. and again later in the day.

Use warm water to wash (but do not soak) excessively dirty eggs. Water which is slightly warmer than the egg opens pores in the egg, making the egg "sweat" and thus helping release dirt. Eggs that are slightly dirty may be cleaned gently with sandpaper, steel wool, or a damp cloth.

Store the eggs in a cool, damp area in a basement or fruit cellar where temperature is about 55 °F and relative humidity is around 75 percent. Store eggs with the air cell up. Quality and hatchability decline if eggs are stored for more than 10 days. Eggs kept for more than 10 days should be stored on their sides and turned daily.

Natural Incubation and Brooding

Most domestic waterfowl lack the instinct to incubate or brood eggs properly, but some people report good success using the Muscovy duck as a “foster mother.”

Waterfowl eggs can also be placed under broody chickens. Turn large waterfowl eggs under a hen three times daily since the eggs are too large for the chicken to turn. A chicken hen can usually cover 7 to 10 duck eggs or 4 to 6 goose eggs. A duck or goose can usually cover 8 to 13 of her own eggs.

Waterfowl eggs usually hatch best in nests located on damp soil or where eggs can be moistened in some way. It helps to sprinkle the eggs daily with warm water. Remove any early hatching ducklings and goslings from the brooding mother as soon as they are dry. Otherwise, the hen may leave the nest before hatching is complete.

Place the female and her brood in a weatherproof coop and provide feed and water. Do not let the young out in tall or wet grass.

Artificial Incubation

Follow the incubator manufacturer’s directions and recommended operating procedures. Machines have different temperature and humidity scales. Waterfowl eggs generally require more moisture during incubation than eggs from other fowl. It is best not to incubate waterfowl eggs with eggs from other birds.

Start and check the incubator before use and monitor the temperature for at least 24 hours before setting the eggs. In a still-air incubator, a thermometer placed so its bulb is level with the top of the egg should read a constant 102 °F. In a forced-air incubator (one with a constantly running fan), the temperature should be 99.5 to 100 °F. Eggs should be at room temperature before they are placed in the incubator.

Eggs lose some moisture during incubation, but this loss should not exceed 15 percent of the original egg weight. A pan of water in the incubator helps maintain humidity levels. The pan should be about as large as the tray of eggs. A sponge in the water increases the surface area for evaporation.

Try to maintain relative humidity at 60 to 70 percent during incubation. Increase relative humidity to 70 to 80 percent at hatching time. Low humidity will cause death if the shell membrane sticks to the young during hatching. Misting eggs with warm water twice daily also helps maintain humidity.

If you hand-turn the eggs in your incubator, mark one side of the egg with an “X” and the other side with an “O” to keep track of the turning schedule. Turn eggs three times daily. It is best if eggs in automatic incubators are turned every 3 hours. Eggs are turned less frequently by hand to avoid excessive cooling when the incubator is opened.

Candle eggs after about 10 days of incubation and remove those rotten or infertile eggs that are totally dark or totally clear. Handle eggs gently. Avoid excessive temperature change during candling and do not remove eggs from the incubator for more than 10 minutes.

Stop turning eggs 2 to 3 days before hatching and place the eggs on their sides in a hatching area. Do not open the incubator again until the hatch is complete, except to add water or adjust the incubator. Make sure the brooder is ready for the ducklings and goslings when they hatch. Birds that hatch after the usual incubation period are usually weak and should not be saved for breeding stock. Hereditary factors may be partially responsible for non-vigorous, late hatchers.

Remove the young birds from the incubator after their down is dry and place them in a brooder.

OTHER CONCERNS

Flight Prevention

All bantam ducks, Muscovy ducks, and Egyptian and Canada geese can fly.

Mature adults can be confined to prevent them from flying. Pinioning waterfowl (removing the last segment of one wing of day-old birds) also prevents flying. Other flight-prevention measures include clipping the flight feathers of one wing using a wing brail. Clip the primaries of only one wing. This procedure must be repeated at each molt.

Lameness

Ducks and geese have very weak leg and thigh joints. Lameness can be a problem if birds are handled improperly or mismanaged. Avoid sudden movements near the flock and never chase waterfowl or grab their legs.

Newly hatched waterfowl are weak-legged and unsteady, especially during the first week, so don't place ducklings and goslings on newspapers or other slippery surfaces. Putting a paper towel or a piece of burlap or cloth on the floor during the first weeks increases traction and will help prevent spraddled legs.

Spraddled legs can sometimes be corrected by loosely tying the legs together above the hock joints until the young bird can stand normally.

The most common cause of lameness in adult waterfowl seems to be "bumblefoot," an infected callus on the foot pad. Bumblefoot occurs when waterfowl walk on very hard-packed and dry surfaces such as concrete floors, hard-packed ground, and gravel. Once the foot pad dries out and cracks, bacteria infect the foot and a pus-filled callus forms. This problem is more prevalent in larger and older birds.

To prevent bumblefoot, cover hard surfaces with a deep layer of dry, fluffy, clean litter or keep birds in grassy areas. Ducks and geese free to swim in fresh water have few problems with bumblefoot. To treat bumblefoot, remove any core or pus from the pad, wash the area thoroughly, and clean it with a bactericide. It also helps to place an infected bird alone in a quiet area, with clean, dry litter and easily accessible water and feed until it gets back on its feet.

Other lameness can be caused by thorns, slivers, or cuts in the foot pad. Remove any dirt or slivers and clean the pad thoroughly.

Blowouts

Blowouts occur when part of the cloaca and oviduct are forced out of the vent, usually when young females lay oversized eggs or when overweight breeding females come into production.

To treat, gently wash the protruding tissue and push the tissue back in the bird as her muscles relax. However, blowouts tend to recur and many birds will die soon after a serious blowout. Some mild blowouts may heal. Since the tendency toward blowouts is thought to be inherited, eliminate females that show this ailment.

Twisted Wing

Twisted wing occurs when the primary feathers on one or both wings grow away from the bird's body. The problem seems to be caused when very rapid growth and development of the primary feathers causes wings to become too heavy to be properly supported. Twisted wing occurs only in domestic waterfowl. Decreasing the protein content of the feed and feeding more fibrous greens can help alleviate the problem. Since twisted wing may be an inherited trait, do not keep affected birds for breeding stock.

Twisted wings can sometimes be corrected if treated early. Align the feathers properly and tie or tape them in the normal position. Release feathers after 3 to 4 days. Repeat the treatment if necessary. However, trying to realign feathers is not always successful, so it is probably best to remove affected birds.

Disease and Parasites

Ducks and geese are seldom affected by disease and parasites, in part because most people raise only a few birds and provide plenty of range. Providing plenty of clean water so waterfowl can clean themselves will prevent infestations of lice and mites.

The following practices are also recommended as preventative measures:

- Raise waterfowl on well-drained soil.
- Keep bedding and laying areas clean.
- Keep feed dry.
- Discourage any contact between your birds and wild waterfowl.

Signs of disease include weak and listless movement, loss of appetite, inactivity, ruffled feathers, and sudden mortality.

Matted eyes can occur if waterfowl are not allowed to submerge their heads in water to flush out their eyes. Disinfect the waterers, separate infected birds, and carefully remove the crusty or sticky pus around the eyes. Provide fresh, clean water so birds can dip their head well over their eyes.

Ducks and geese may ingest nails, pieces of glass, wire, or other objects which can cause internal bleeding, suffocation, or loss of balance. Remove small and sharp objects from the pens and range of ducks and geese.

If any unusual symptoms occur, isolate affected birds and contact your state diagnostic lab, veterinarian, or an experienced waterfowl breeder to help diagnose diseases or ailments.

EXHIBITING WATERFOWL

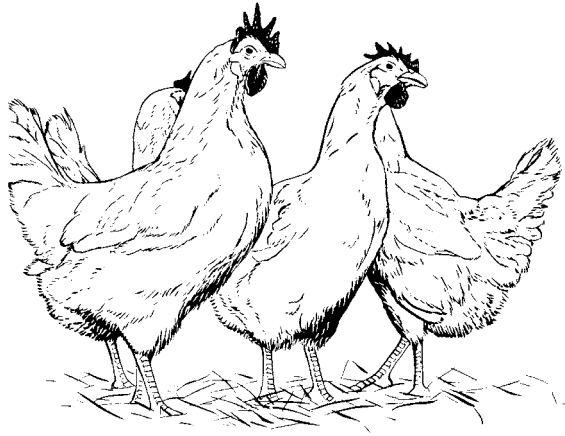
Raising waterfowl for exhibition can foster pride in your flock. Many poultry fanciers establish clubs and sponsor shows. Consider the following factors when exhibiting poultry:

- Raise show-quality birds, purchased from a reputable breeder known to be breeding for conformation to the standard. Know the standard for the breed as described in the American Poultry Association's *Standard of Perfection* and understand the judging system.
- Select birds which best represent the standard for both breeding and exhibiting. Exhibit birds and talk to other breeders and judges to learn more about showing and breeding. Enter several birds which you feel best represent the standard.
- Ask breeders about shows, poultry clubs, and poultry publications. *Poultry Press* magazine lists shows and provides other valuable information.

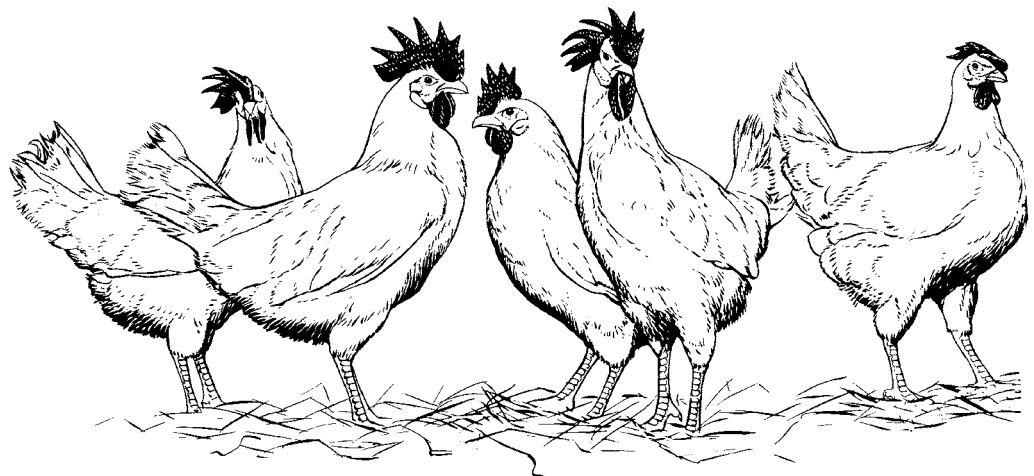
Preparing waterfowl for show is relatively easy. Birds raised in clean pens and with access to plenty of fresh water will keep themselves clean. Place birds in a special grassy pen with fresh water for 2 weeks before they show so they will clean themselves. Their feet and bills may require additional cleaning with a damp cloth or soft brush.

Transport waterfowl in sturdy and well-ventilated wire cages, wood boxes, or cardboard boxes which provide ample space to avoid injury and keep birds clean. Use plenty of fresh litter in the transport coop so birds remain comfortable and clean. Carrying cages may be purchased or made. Avoid drafts during transport and never transport birds in the trunk of an automobile since they may suffocate or die due to exhaust system fumes. Exhibition is a learning experience and an enjoyable aspect of waterfowl breeding.

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Avian Systems



THE REPRODUCTIVE SYSTEM

Female Reproductive System

(See Figure 3)

The female reproductive system of the chicken is divided into two main parts: the **ovary** and the **oviduct**. The **ovary** is a cluster of developing **yolks** or **ova** and is located midway between the neck and tail of the bird, attached along the back. The ovary is fully formed although very small when the female chick is hatched. It is made up of 13,000 to 14,000 minute yolks or ova which grow by the addition of yolk fluid. The ovum, or yolk starts out as a single cell surrounded by a **vitelline membrane** which keeps water out. The color of the yolk or ovum, which is yellow/orange comes from fat soluble pigments called xanthophylls (*xantho fills*) contained in the hen's diet.

Ovulation is the release of the mature yolk from the ovary into the second part of the female reproductive system. The ova or yolk, which is enclosed in a sac, ruptures along the **suture line** or **stigma**. This release of the ova occurs 30 to 75 minutes after the previous egg has been laid.

The second major part of the female chicken's reproductive system is the oviduct. The **oviduct** is a long convoluted tube (25 to 27 inches long) which is divided into five major sections. They are the **infundibulum** or **funnel**, the **magnum**, the **isthmus**, the **shell gland**, and the **vagina**. Unlike mammals, there is only one functional oviduct in the chicken; the oviduct on the left side of the chicken is functional, the right ovary is **rudimentary** (imperfectly developed).

The first part of the oviduct, the **infundibulum** or **funnel**, is 3 to 4 inches long, and it engulfs the ovum released from the ovary. The ovum or yolk remains here 15 to 18 minutes, and the infundibulum also serves as a reservoir for spermatazoa so that fertilization can take place.

The next section of the oviduct is the **magnum** which is 13 inches long and is the largest section of the oviduct as its name implies. The ovum or yolk remains here 3 hours during which time the thick white or albumen is added.

The third section of the oviduct is the **isthmus** which is 4 inches long. The "egg" remains here for 75 minutes. The isthmus, as its name implies, is slightly constricted. In the isthmus, the shell membranes are added.

The next section of the oviduct is the **shell gland**. The shell gland is 4 to 5 inches long, and the "egg" remains here for 20-plus hours. Plumping is the addition of water in the shell gland and is vital to the creation of the thin albumen and chalazae. As its name implies, the shell is placed on the egg here. The shell is made up of **calcium carbonate**, and the hen mobilizes 47 percent of her body calcium from her bones and her diet to make the egg shell. Pigment deposition is also done in the shell gland.

The last part of the oviduct is the **vagina** which is about 4 to 5 inches long and does not really play a part in egg formation. The vagina is made of smooth muscle which helps push the egg out of the hen's body. There are also glands located in the vagina where spermatazoa are stored.

Male Reproductive System

(See Figure 4)

The male reproductive tract is comprised of two **testes**, both of which are functional. Inside the testes are the **seminiferous tubules**, where spermatazoa are produced. Leading from the testes is the **ductus deferens** which move the sperm to the outside of the body.

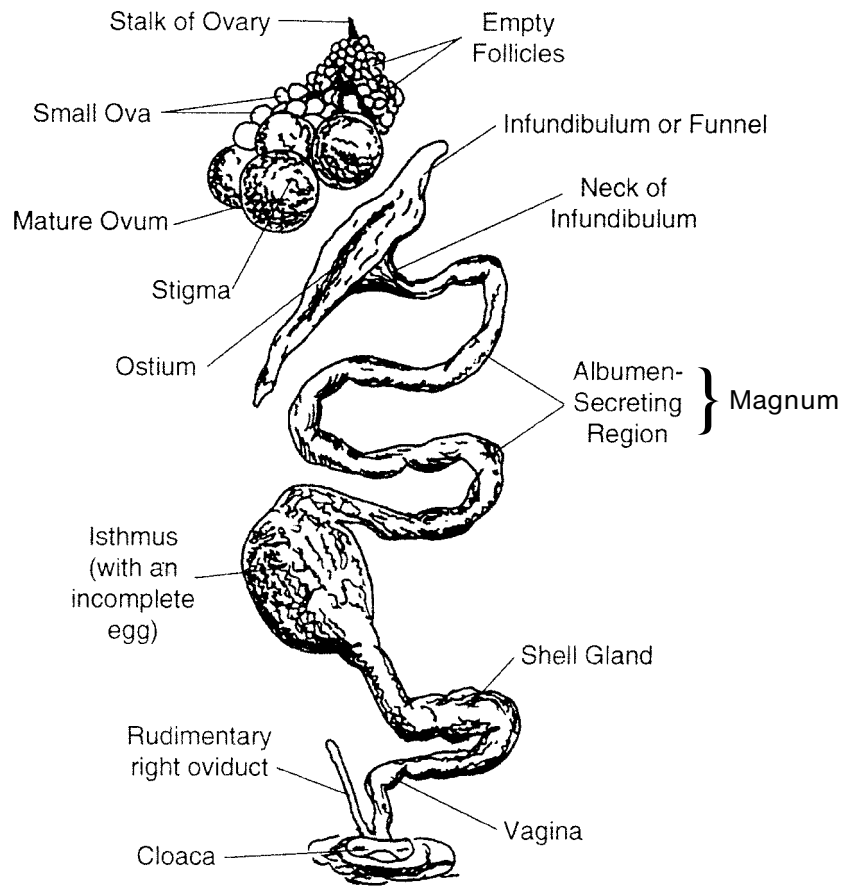


Figure 3. Female Reproductive System

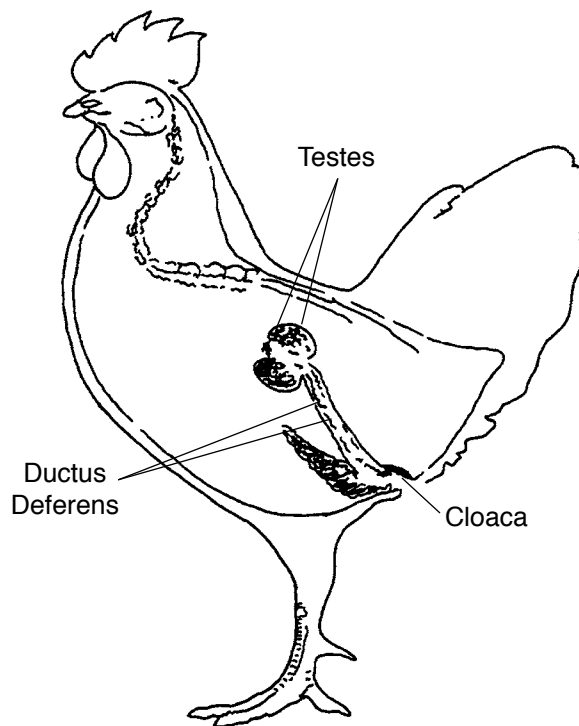


Figure 4. Male Reproductive System

THE CIRCULATORY SYSTEM

The chicken has a four-chambered heart similar to a human heart, including two ventricles and two atria. The heart rate of a Leghorn female is about 350 beats per minute, and a New Hampshire male has a heart rate of 250 beats per minute. The function of the circulatory system is to transport oxygen, carbon dioxide, metabolites, hormones, and nutrients throughout the body and to aid in temperature regulation, keeping the chicken's body temperature at 106 °F. The red blood cells and white blood cells are formed in the spleen. A bird's red blood cells are unique in that they are **nucleated** whereas a mammal's are not. This means there is a nucleus in the red blood cell. See Figure 5 below.



Figure 5. Red Blood Cells

THE NERVOUS SYSTEM

The nervous system is divided into two main parts which are the **central nervous system (CNS)** and the **autonomic nervous system (ANS)**. The CNS is responsible for the voluntary actions of the body such as movement or flight, and the ANS is responsible for the coordination of involuntary actions of the organs, intestines, blood vessels, and glands. The primary function of the nervous system is to integrate the functions of the body.

THE EXCRETORY SYSTEM

(See Figure 7)

The main organ of the excretory system is the **kidney**. The functional units of the kidney are **nephrons**. The functions of the excretory system are to excrete water and metabolic wastes and to regulate the acid-base balance in the bird's body.

The primary component of poultry waste is **uric acid**, the major end product of protein utilization. Uric acid is a white, pasty substance. Poultry waste is comprised of urine and feces; these are not separate.

THE MUSCLE SYSTEM

Muscle is the principle contractile organ of the body which is responsible for movement. There are three types of muscle in a bird's body: **smooth**, **cardiac**, and **skeletal**. **Smooth** muscle is controlled by the **autonomic nervous system** and is found in the blood vessels, gizzard, intestines, and organs. The **cardiac** muscle is the specialized muscle of the heart. The **skeletal** muscle is the type of muscle responsible for the shape of the bird and for its voluntary movement. This is the muscle which makes up the edible portion of the carcass. The most valuable skeletal muscles on a poultry carcass are the breast, thigh, and leg.

THE SKELETAL SYSTEM

The skeletal system is important to the bird for **support** and has two additional functions which are unique: **respiration** and **calcium transport**. The skeletal system of the bird is compact and lightweight, yet strong. The tail and neck vertebrae are movable, and the body vertebrae are fused together to give the body sufficient strength to support the wings.

There are two special types of bones which make up the bird's skeletal system: they are **pneumatic bones** and **medullary bones**. The pneumatic bones are important to the bird for respiration. They are hollow bones which are connected to the bird's respiratory system and are important for the bird to breathe. Examples of pneumatic bones are the skull, humerus, clavicle, keel (sternum), pelvic girdle, and the lumbar and sacral vertebrae. Vetebra is singular, vertebrae is plural.

The medullary bones are an important source of calcium for the laying hen. Calcium is the primary component of egg shell and a hen mobilizes 47 percent of her body calcium to make the egg shell. Examples of medullary bones are the tibia, femur, pubic bone, ribs, ulna, toes, and scapula.

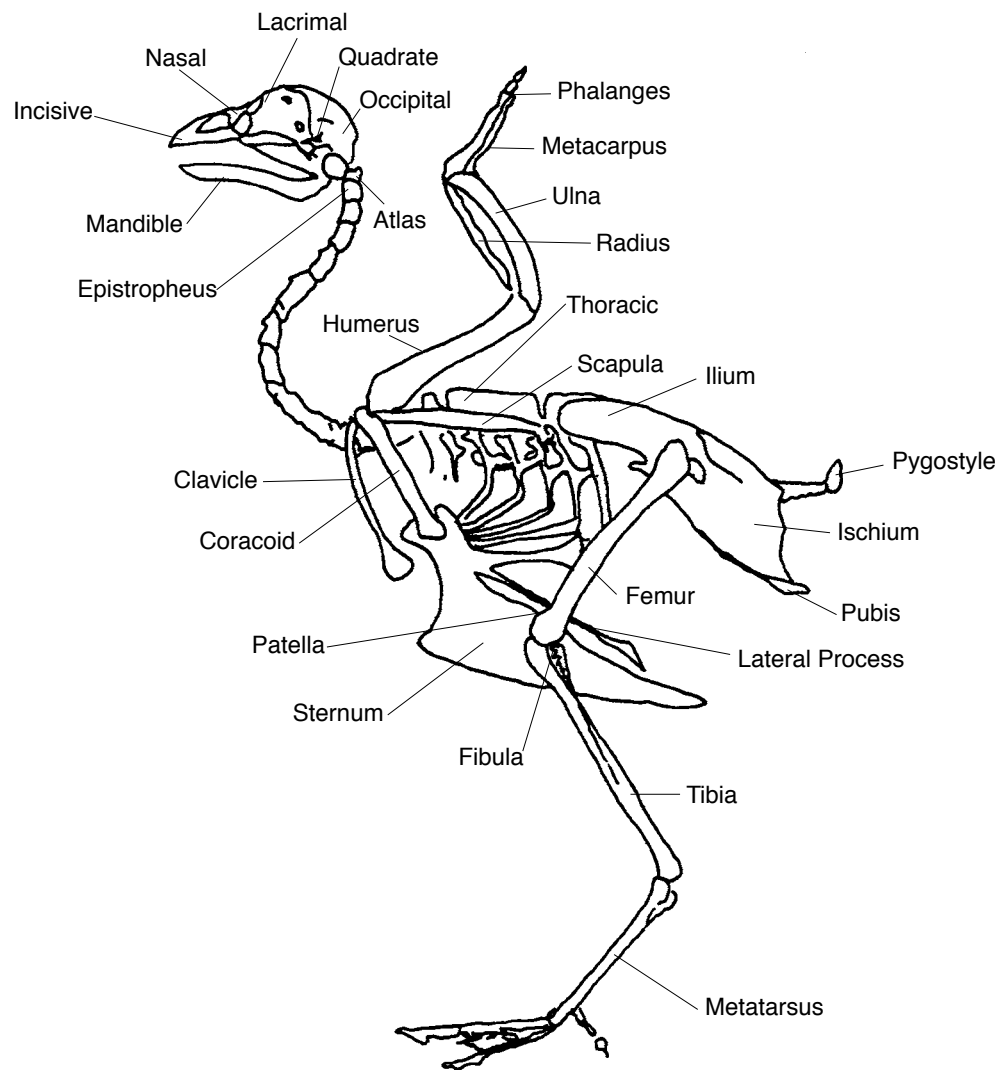


Figure 6. Skeletal System

THE RESPIRATORY SYSTEM

The respiratory system is made up of **lungs**, **pneumatic bones**, and **air sacs**. The lungs of the bird are different from those of the mammal, in that the bird's lungs are rigid. They function in the exchange of blood gases such as CO₂ and O₂. **Air sacs** are unique to the bird and are flexible. The air sacs open up to the pneumatic bones which aid in the exchange of air throughout the bird's body. There are four pair of air sacs and one single air sac, two **interclavicular** air sacs, two **abdominal** air sacs, two **anterior thoracic** air sacs, two **posterior thoracic** air sacs, and one **cervical** air sac. The respiratory system is important for air exchange and also for temperature regulation in the bird.

THE DIGESTIVE SYSTEM

(See Figure 7)

The digestive system functions to utilize food material for the maintenance of all the other systems of the bird's body. The bird's digestive system depends on enzymes (proteins) which chemically break down the food. The digestive system is made up of many different parts. The **mouth** contains salivary glands that secrete saliva containing enzymes which begin to break down food. A bird does not have teeth to chew its food but does have a tongue which pushes the food to the back of the mouth so that it can begin its passage down the rest of the digestive tract. The **esophagus** is the tube that connects the mouth with the rest of the digestive tract. The **crop** is located in the neck region and found between the anterior and posterior esophagus. The **proventriculus** or **true stomach** secretes hydrochloric acid (HCl) and the enzyme, pepsin. Another unique part of the bird's digestive tract is the **gizzard**. The gizzard is made up of two smooth muscles and contains grit or stones and acts as the bird's teeth by grinding the food.

The **small intestine** is made up of the duodenum and the lower small intestine. The small intestine is important for the absorption of nutrients. The **ceca** are two blind-end pouches that are the site of water absorption, microbial activity and the production of B vitamins. The last portion of the digestive tract is the **rectum** or **large intestine** where additional absorption of water takes place.

The **pancreas**, which is in the center of the duodenal loop, secretes pancreatic juice which neutralizes the HCl secreted by the proventriculus and helps break down fat. The **liver** produces a dark green substance called bile which is necessary for the absorption of fats. The bile is stored in the gall bladder, and when food passes into the duodenum, it causes the gall bladder to empty the bile into the small intestine.

The **cloaca** is where the **digestive tract**, the **reproductive tract**, and the **excretory tract** all end up. The cloaca is important for absorbing any moisture from foodstuffs which will leave the body. It is also important since it is here that the egg from the female's reproductive tract is flipped in order that it will be laid large end first.

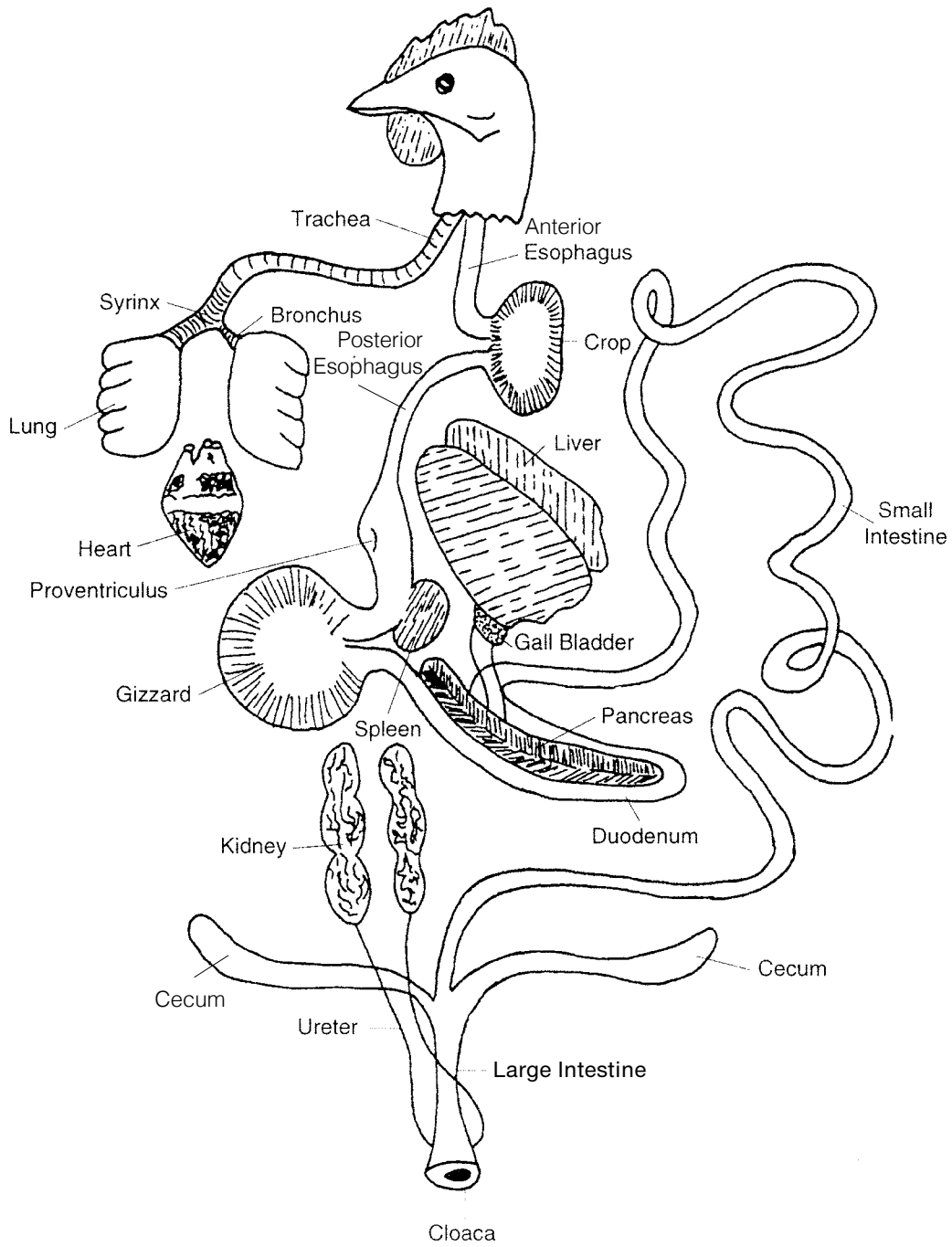


Figure 7. Digestive System and Excretory System

THE FEATHER

Although the feather is not a system of the bird, it is what makes the bird totally unique from all other animals. Figure 8 shows the parts of the feather. The feather is important for **flight, protection, and temperature regulation**. When a bird rearranges its barbules and barbicels, it is called **preening**. Birds also lose their feathers once a year during a **molt**. These feathers are replaced in about 21 days.

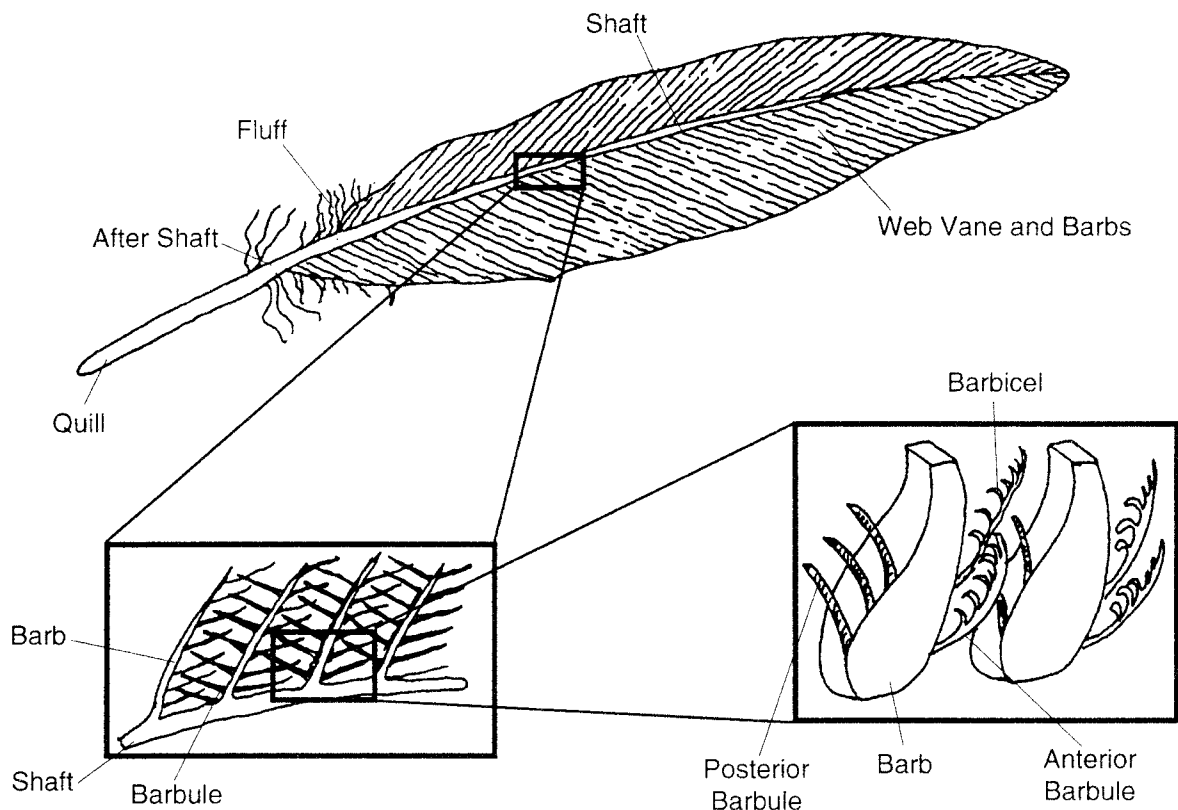
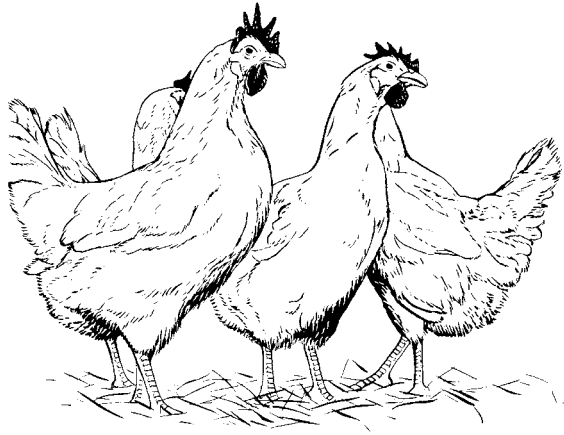
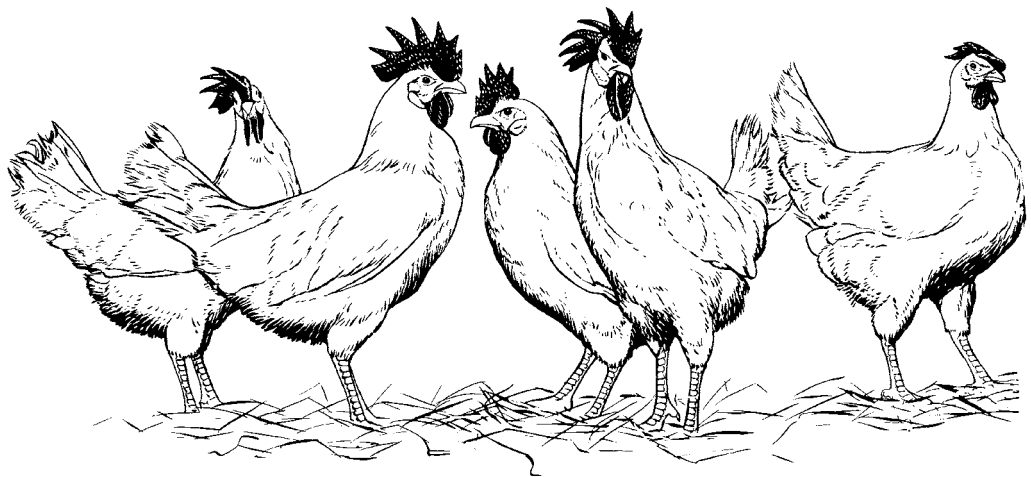


Figure 8. Parts of the Feather

*Acknowledgments: Michelle A. Hall, Professor Emerita
Animal & Veterinary Science Department, Clemson University*



Small Turkey Flock Management



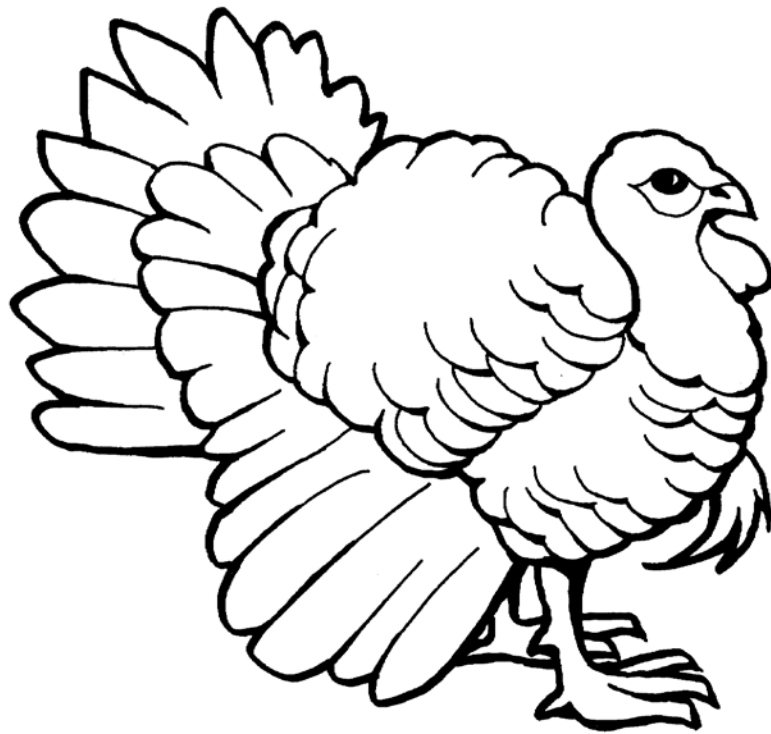
SMALL TURKEY FLOCK MANAGEMENT

Raising a small flock of turkeys can serve two basic purposes. First, you can produce some of your own food and have the freshest turkey possible. Second, you can involve the whole family in a project working with and learning about live animals. Then, too, you may be able to compete economically with commercial turkey growers.

A small number of turkeys can be raised in a relatively small area, but be sure to inquire about local laws and ordinances before starting your flock. Zoning regulations in some towns and suburbs prohibit keeping poultry. While little time is required to care for turkeys, their care must be regular — at least once a day and more often when the birds are young.

Buying Poults

The “breeds” of turkeys often referred to are actually varieties that originated from the wild turkey. The most commonly raised commercial variety is the Large White. Hens commonly reach a live weight of 17.4 pounds at 20 weeks of age and toms weigh about 34.4 pounds at 24 weeks. Smaller fryer-roasters can be produced by slaughtering the Large White turkey at an earlier age.



The small flock is generally started after the threat of cold weather is past, anytime from April to June. This reduces the need for insulated housing and saves appreciably on fuel costs for brooding. Brooding is practical if you start at least 20 poults. For smaller flocks, try to purchase 6- or 8-week-old poults from a local commercial grower. At this age they should no longer require brooding if the weather is moderate.

When purchasing day-old poults, buy from a hatchery (locally if possible) that maintains healthy, good-quality stock. Poults should be free from pullorum, sinusitis, and other disease. To further reduce the threat of disease, raise turkeys away from other poultry. Sinusitis and blackhead can be serious problems in turkeys raised among chickens or on ground where chickens have been within the last three years.

Flock Size

When determining the number of turkeys you want to raise, consider the facilities, equipment, and space you have available. Crowding turkeys leads to problems and does not pay. Also consider the number of turkeys you can market live and the number you can slaughter and use or sell. Be sure to check state regulations regarding the use and sale of dressed (or ready-to-cook) turkeys. Some states (Indiana, for example) prohibit the sale of any turkeys unless dressed in an inspected plant, while others provide exemptions for growers of small turkey flocks. Available labor, however, should be only a minor consideration as little additional time is required to care for a greater number of birds.

Housing

Turkeys require a brooder house that can be kept warm, dry, well-ventilated, and free from drafts. Allow at least 1½ square feet of floor space per poult up to 8 weeks of age. From 8 weeks to market age, provide 5 to 8 square feet of housing space per bird depending on the size to which they will be grown. Ventilation becomes increasingly important as the turkeys get larger and as hot weather approaches.

Preparing Brooding Area

Well before the poults are due to arrive, clean the brooder house thoroughly. Brush loose dirt and cobwebs from the ceiling, walls, and floor. Wet down and scrape areas as needed to remove caked materials and then scrub the walls and floor with a good disinfectant, such as quaternary ammonium compounds. High-pressure washers do a good job of cleaning. After rinsing, allow the area to dry thoroughly and air out. Check roof and walls for leaks or cracks and make any necessary repairs. Rodents, wild birds, predators, and pets should be kept out of the turkey pen at all times. They can spread diseases or scare the poults, causing them to pile and smother. Check the electrical system and correct any faults. Clean and make needed repairs on feeders, waterers, brooders, and other equipment.

Cover the brooding area with at least 2 inches of litter. A good litter is clean, dry, absorbent, and relatively free from dust. Commonly used litter materials include wood shavings, chopped straw, peat moss, or other commercial litters. Since litter absorbs moisture and insulates the birds from the cold floor, it is important to remove any areas that become wet and then add more litter as needed. Do not cover litter with slick-surfaced materials (such as newspaper) as these can cause slipping—and serious leg injuries to the poults.

Set up the brooder and test its operation. When used, infrared lamp brooders should be hung at least 18 inches above the litter. Follow manufacturer's directions for other types of brooding units. Keep a spare lamp on hand to replace burned-out lamps.

A brooder guard is a barrier placed around the brooder to keep the poults near the heat source and to prevent drafts from reaching baby poults. The guard should be used for the first 7 to 10 days until the poults become familiar with the source of heat. The guard should be at least 1 foot high and long enough to form a complete circle about 3 to 5 feet from the brooder. Rolls of corrugated cardboard are sold for this purpose but other materials, such as tarred paper, can be used. In hot weather, fine mesh wire can be used if the house is not drafty. Brace the brooder guard, if necessary, to ensure that it stays in place.

Set the feeders and waterers in place near the edge of the hover or form an open wheel pattern around the infrared brooder (see Figure 9). The number and size of feeders and waterers used depends on the number of poults in your flock and will be discussed later. It is advisable to have at least two of each in a pen to help the poults find feed and water. In addition to the regular feeders, place small piles of feed in shallow boxtops or paper plates for the first few days.

Brooding

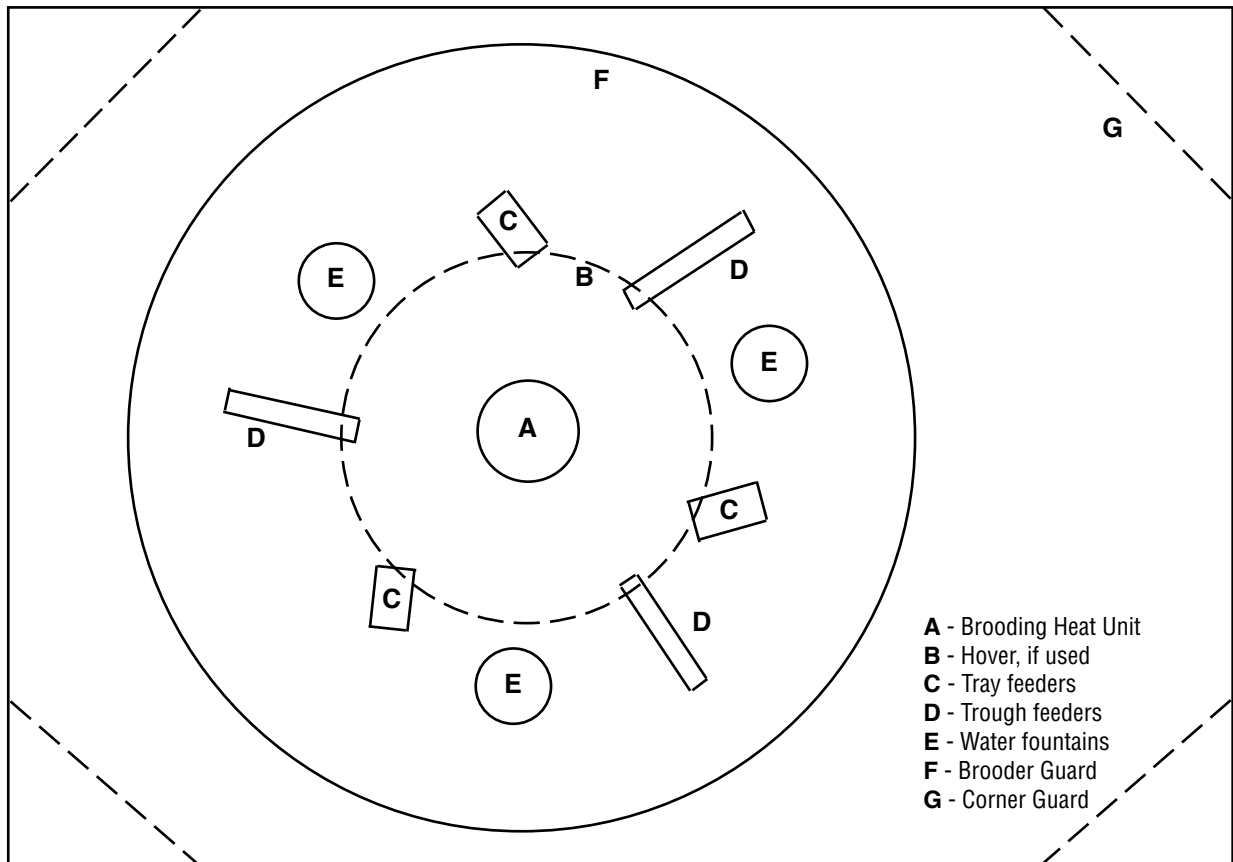


Figure 9. Brooding Arrangement

A dependable source of artificial heat is required to brood poults. Provide a uniform 90 to 95 °F temperature at the poults' level during the first week. Thereafter, lower the temperature by 5 degrees each week until it reaches 70 °F. Maintain this level until supplementary heat is no longer needed. The length of time supplementary heat should be provided will vary with weather conditions. After the poults are 6 to 8 weeks of age, heat is generally needed only during abnormally cold spells.

Brooders using infrared heat bulbs can be made or purchased for a small flock. Using two-bulb brooders is recommended as they offer a safety factor in case one bulb burns out. A single-bulb unit, however, will normally be adequate for late spring and early summer brooding. Single-bulb units do not have thermostats. This makes uniform heat maintenance more difficult when the weather changes. Multiple-bulb units, on the other hand, often have a thermostat which allows one bulb to be on constantly and turns on additional bulbs as needed. Common types of brooders are illustrated in Figure 10.

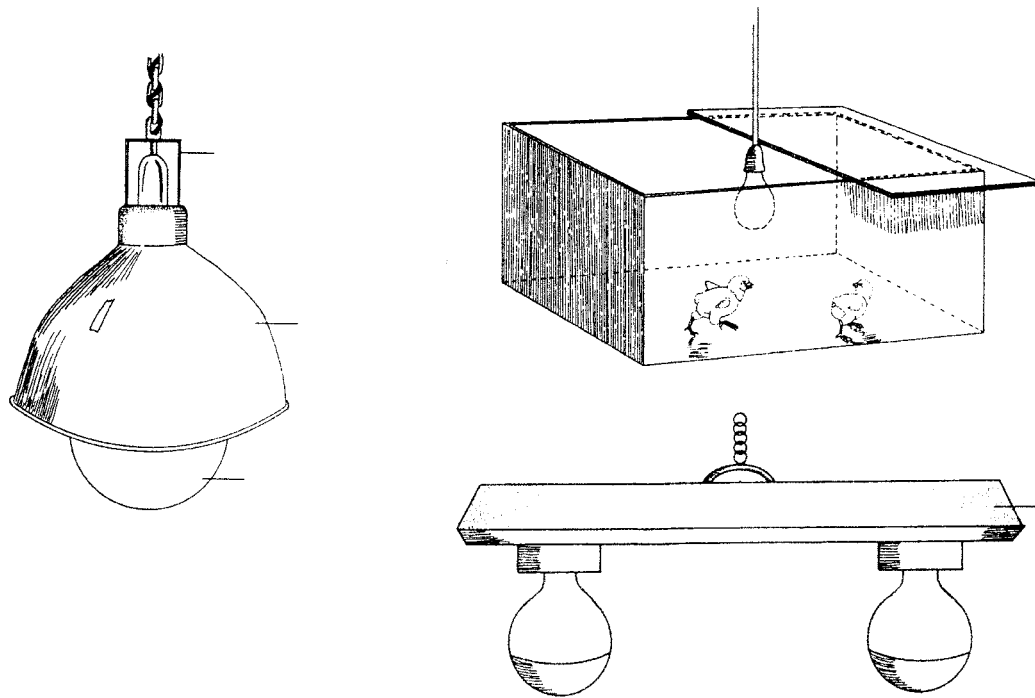


Figure 10. Brooders Commonly Used for Small Flocks.

A commercial-type electric or gas brooder can be used for brooding 100 or more poults. These usually include automatic controls and a hover that directs the heat down on the poults. Gas brooders with an open flame must be carefully maintained to eliminate fire hazards. Several types of gas catalytic brooders, which work on an infrared principle instead of having an open flame, are also available.

Start the brooder the day before the poults are to arrive as a final check on its operation and to prewarm and dry the brooding area for the poults. Use a thermometer to check the brooder and see that it steadily maintains the desired starting temperature of 90 to 95 °F. After some experience observing poults, you will be able to tell whether they are comfortable. If, for example, more heat is needed, poults will tend to huddle together under the center of the brooder. If they move away from the heat source, the temperature is too high. If they consistently occupy one side of the brooding area, they are trying to escape a drafty area. Comfortable poults, on the other hand, will spread uniformly under and around the edge of the brooder.

Fill the feeders and waterers before the poults arrive so they can be placed under the brooder immediately upon arrival. Lukewarm water should be provided for the first several days. Turkey poults are subject to dehydration. To help them learn to drink, dip their beaks into the water fountains when placing them under the brooder. Repeat this process with several poults later in the day if there is any doubt about their having found the water. Keep a frequent check, too, on the brooder temperature and the poults during the first week.

Range Rearing

Turkeys can be raised to maturity in confinement, but most small flock owners will range turkeys during the summer and fall months. Turkeys should not be allowed to run with chickens, or on a range used for chickens in the past three years. These precautions, once

again, help control diseases. Chickens can appear normal while carrying and shedding organisms that cause blackhead disease. These disease organisms can survive for long periods of time in the soil.

Allow at least 30 square feet of good grass or clover range per turkey. Select a well-drained area with adequate shade from trees or with shelters that allow birds protection from the mid-day sun without crowding. Heavy turkeys, especially as they near maturity, do not tolerate high temperatures well. Range shelters also provide needed protection from rain. Move range feeders and waterers weekly to prevent complete trampling of grass immediately surrounding the equipment.

Enclose the range area with a 4-foot fence having sufficiently small mesh to keep out potential predatory animals. Roosts are not necessary for the turkeys but can be provided if desired by laying 2 by 4-inch boards flat, 24 inches apart and 15 inches above the ground. Allow 10 to 12 inches of roost space per turkey.

In mild weather, turkeys can be put on range at 6-8 weeks of age if they have access to the house or a range shelter. During cooler weather, wait until they are 12 weeks of age or allow the birds outside only during warm periods. Schedule your flock placement so the birds will be marketed before the threat of cold weather. If this is not possible, be sure to provide adequate housing in the late fall or early winter.

Feeding

Turkeys are fast-growing and efficient converters of feedstuffs to high-quality meat. The feeding of properly balanced rations will result in the best performance. Poults should be given a 28-percent protein turkey-starting mash for 6 to 8 weeks. This gets the birds off to a good start while their feed intake is relatively low. From that point a turkey-growing ration (mash, crumbles, or pellets) containing 22 percent protein is recommended. Do not change abruptly from mash to pelleted feeds.

Feed containing less protein can be fed after 12 weeks of age. Complete growing rations with lower protein levels may be purchased, or whole or cracked grains (about 10 percent protein), such as corn and oats, can be fed along with the growing ration to increase the energy and reduce the protein intake. For example, one part grain to three parts of the 22-percent protein growing ration will provide a 19-percent protein mixture which is satisfactory for turkeys from 12 to 16 weeks. From 16 weeks of age to market, mix equal parts of grain and the growing ration to provide 16 percent protein. Grit should be available if whole or cracked grains are used.

Check the protein level of the finishing ration to determine whether mixing grains with the ration should be continued. The protein level should not drop below 14 percent. The amount of each type of feed needed can be estimated from Table 9, depending on the type of turkeys (large or small) raised and the market age and size you choose. Check the feed manufacturer's directions and follow them. Some growing feeds contain drugs to control disease. The feeding of these drugs must be discontinued for a specified length of time before the turkeys are slaughtered. This information should be given on the feed tag. Feed manufacturers can provide finishing rations without drugs.

Feed should be available to the growing turkeys at all times. Observe the poults during the first 2 days to be sure they are eating. Some flocks seem to have trouble finding the feed early, resulting in death loss from "starve outs." If necessary, set some of the poults in the shallow box-tops or plates containing feed to help them start. Others will usually soon follow their example.

Adequate feeder space ensures that all birds in the flock have an opportunity to eat. See Table 10 for feeder size recommendations. To determine the feeder length needed, total the length of both sides of trough-type feeders; a 2-foot feeder provides 48 inches of trough length.

Table 9. Recommended Minimum Feeder Space for Turkeys for Trough-type Feeders*

<u>Age of Poults</u>	<u>Feeder Length</u>	<u>Feeder Depth</u>
0 to 4 weeks	2" per poult	2 to 3"
4 to 8 weeks	4" per poult*	5" with lip
Over 8 weeks	6" per poult*	8" with lip

*Feeders space requirements may be reduced by about 25 percent when using tube-type or other round feeders.

Start poults with at least two well-filled small trough feeders and with several shallow box-tops or paper plates with a small handful of feed. Once the poults are eating well, reduce the level of feed in the trough for the second week to about three-quarters full and not more than half-full thereafter. Poults will waste feed if the trough is overfilled.

Adjust the feeders so all birds can eat easily. The proper height is about even with the top of the birds' backs. A reel or grill on trough feeders will help prevent feed wastage by keeping the poults out of the feeder. Make sure, however, that it does not interfere with the birds' ability to get to the feed. Running a finger along the inner edges of the trough feeder will attract the poults to the feed, and ridging the feed along the center of the trough will make it more visible. Tube-type feeders, often used for turkeys after 4 weeks of age, have a reservoir of feed which requires less-frequent filling.

Water

Adequate water of good quality is essential for all kinds of poultry. Start your poults with at least two water fountains and at least one 1-gallon fountain for each 50 poults. Glass or plastic fountains are usually used for the first 2 weeks and gradually replaced with larger metal fountains, pans, or troughs. If water is available in or near the pen or range area, an automatic waterer that connects to a heavy garden hose can be used. The minimum amounts of linear waterer space should be one-half an inch per poult to 4 weeks of age; 1 inch per poult to 8 weeks of age; and 1½ inches per turkey to market age.

Raise the waterers as the turkeys grow and place the larger waterers on a wire platform to contain spilled water and keep litter out of the water. As new waterers are introduced, leave some of the smaller units in place until the flock becomes used to the new system. Depending on the type of waterers used, it may be necessary to anchor waterers in place to keep them from being upset by turkeys as they grow larger.

Choose waterers that are easily cleaned and designed so that turkeys will not get their feet into the water. Waterers should be cleaned and refilled with fresh water daily.

Lighting

Young poults appear to have poor vision, so adequate lighting will help them find feed and water more readily. Infrared brooder lamps will provide adequate light for poults brooded under this system. If other brooding systems are used, artificial lights should be used to provide a minimum of 15 foot-candles of light at the feeders and waterers for the first 3 weeks. Thereafter, dim lights providing about one foot-candle of light will help reduce restlessness, nervousness, and flightiness in the flock. (Note: To judge light levels, 15 foot-candles is approximately the amount of light you would have in a well-lit room in your home. With one foot-candle of light, you would just be able, with some difficulty, to read newsprint.) Range turkeys should do well with only natural daylight.

Disease Prevention

Management is the key to maintaining the health of your flock. Good sanitation and elimination of other birds and animals that may carry disease organisms are important factors in maintaining a healthy flock. Keeping the pen and range areas dry will also help. Vaccines, available for several turkey diseases, may not be necessary for a small flock unless previous disease problems existed on your premises or on nearby farms. Other disease problems can be controlled through the use of medicated feeds, if necessary. However, clean stock, clean premises, and good management are the best lines of defense.

If your flock does become sick, an accurate diagnosis and recommended treatment should be obtained. State diagnostic laboratories usually offer low-cost or free diagnostic services. Take typically sick or fresh, dead birds to the laboratory for evaluation. Along with the birds, take a complete flock history including age, feeding program, vaccinations, or drugs used and a description of the course of the current problems.

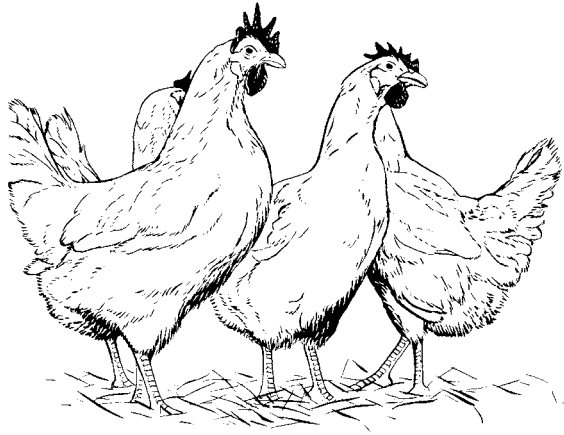
Some death loss is normal and should be expected, especially during the first 2 weeks. However, it is important to get an early diagnosis of disease problems in order to stop the spread of disease throughout the flock. A good feed or hatchery serviceperson can give you helpful advice on many day-to-day problems.

Marketing and Processing

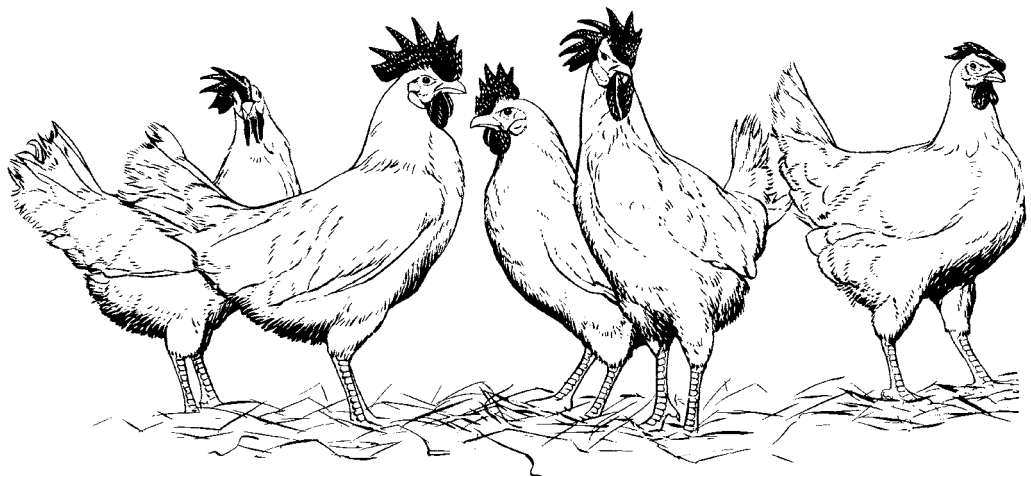
If you have more turkeys than you will need, you may be able to sell some, either alive or dressed. State and federal laws regulate the sale of processed birds but limited processing for direct sale to consumers is exempt in some cases. For details on regulations, contact your Extension Service or State Department of Agriculture personnel.

Processing turkeys at home is not really difficult but you may find it more convenient to have them custom processed. For information on home processing and other aspects of turkey flock management, contact your county or State Extension Service office.

Acknowledgments: Louis C. Arrington, University of Wisconsin, Cooperative Extension Service



Growing Blue Ribbon Pullets



GROWING BLUE RIBBON PULLETS

Breed Selection

Before you choose a breed and variety for your project, decide whether you want to raise chickens for eggs or meat.

Egg-type

Single Comb White Leghorns and Leghorn-type hybrids are used for egg production. These birds live well, grow fast, and begin laying eggs at 5 to 5½ months of age. They have small bodies and do not consume as much feed as larger meat-type birds. They have been bred to lay a large number of high-quality, white-shelled eggs.

The Leghorn-type cockerel does not grow fast and does not make a good broiler. If you select egg-type birds, buy only female chicks.

Meat-type

The meat-type birds are a cross between a strain of Cornish game and a brown-egg meat-type bird such as White Plymouth Rocks, Columbians, Plymouth Rocks, and New Hampshires.

Broiler-type chickens convert feed efficiently, grow and feather rapidly, and are ready to dress for home use at 8 to 8½ weeks. They should not be kept for market egg production, because they do not produce eggs as efficiently as egg-type birds.

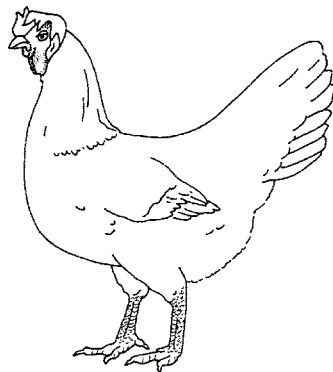
Dual-purpose

The dual-purpose birds were developed to provide both eggs and meat. These birds do not produce eggs as efficiently as birds of the egg-type strains, nor can they produce meat as efficiently as birds selected for meat production. Dual-purpose birds include Rhode Island Reds, White Plymouth Rocks, New Hampshires, Barred Plymouth Rocks, Black Sex Links, and Red Sex Links.

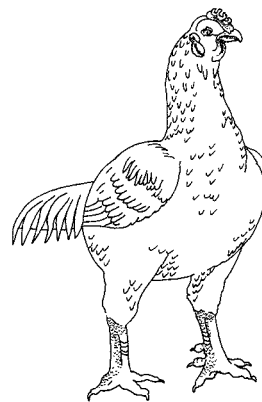
Black Sex Linked chickens are a cross of any variety of male besides a Barred or Dominant White (RIR, Black Australorp, Buff Orpington, etc.) crossed with a female with the Barred Gene (Barred Plymouth Rock, Cuckoo Maran, Barred Holland, etc.)

Red Sex Linked are a cross of a red/gold gene rooster (Rhode Island Red, New Hampshire, Brown or Red Ameraucana, etc.) crossed with a Silver gene hen (Delaware, Silver Leghorn, Columbian Wyandotte, etc.).

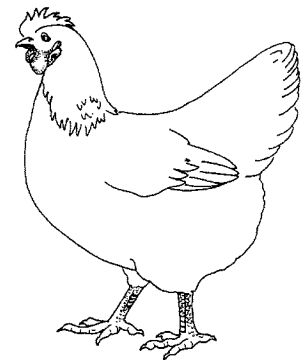
The dual-purpose birds are hardy, lay large brown-shell eggs, and are well-suited for the backyard flock.



Egg-type Chicken



Meat-type Chicken



Dual-purpose Chicken

Where to Buy Chicks

Start your project by participating in the 4-H Pullet Chain. Each 4-H member who participates in the program receives 25 to 50 free chicks to brood and rear. The 4-H'ers agree to return six or more pullets to the show and sale. Contestants receive ribbons and prize money based on their success in raising blue ribbon pullets.

An alternative is to purchase well-bred, healthy chicks from a reputable hatchery that breeds stock for efficient production. The hatchery should be a member of the National Poultry Improvement Plan. These hatcheries blood-test their breeding flocks for pullorum and typhoid and produce chicks from birds that do not have these diseases. The Agricultural Extension Service agent in your county can furnish you with a list of hatcheries that operate under the National Poultry Improvement Plan. Order your chicks at least 4 weeks before the date you would like to start them.

How Many Chicks to Buy

Discuss your plans with your parents, giving careful consideration to the following:

1. Size of the poultry house.
2. Brooding equipment such as feeders, waterers, and brooder needed for the project.
3. The amount and cost of feed.
4. Amount of time you can give to your project.
5. Whether you can continue with the project in the fall and winter if you decided to raise birds for egg production.
6. Whether you have a market for the eggs or meat.

If you want 25 mature pullets, then you need to purchase approximately 30 to 35 chicks. Purchase only pullets rather than straight-run egg-type chicks. A straight run means a combination of pullets and cockerels. The egg-type cockerels grow slower than meat-type birds. They require more feed and are very poor converters of feed to meat.

In a broiler flock, a 5-percent mortality rate is considered high. It will not be necessary to buy many more chicks than you plan to market.

It is important that the flock size be right for the housing space and equipment available. Twenty-five to 50 chicks will provide enough eggs and some meat for your family. A larger flock can become a source of income, provided there is a local demand for your eggs and meat.

When to Start Brooding Chicks

March and April are the months to start chicks for small 4-H laying flocks. It is easier to brood the chicks when the weather is beginning to get warmer, and they will come into production in the fall and winter. If you plan to show your birds in competition, they will be more fully developed than chicks hatched at a later date. Leghorn-types will start laying at about 5 months, while the dual-purpose birds will start to lay in about 6 months.

Chicks purchased for meat production can be started at any time. It takes about 8 to 8½ weeks to produce a 3½- to 4-pound fryer, when a good broiler stock is selected. Since broiler chicks grow fast, they are ready for market soon after the brooding period.

Housing Requirements

You must provide a shelter for your chickens. The birds should be comfortable while in your care. A house protects them from the weather. It also keeps out rodents, wild birds, and large animals. Plans for small poultry houses can be obtained from a Poultry Extension Specialist.

Housing and equipment for chickens does not need to be elaborate or expensive. There are, however, several factors that must be considered in order to grow healthy and vigorous birds. These factors include: space, draft-free ventilation, light, temperature, easy access to feed and water, roosts, and nests.

As the birds progress from the brooding period to the growing period and then to the laying stage, the factors change to meet the birds' needs. As you read this manual, pay attention to these factors. They will help you manage your birds properly.

Brooding Chicks

Baby chicks require lots of tender loving care. They depend on you for all their needs. The brooding period lasts about 6 weeks. If you practice the following management techniques during the brooding period, you should have a healthy flock.

1. **Space** - Each chick should have one-half a square foot or more of floor space for the first 4 to 5 weeks. If broilers are to be housed indoors until ready for market, 1 square foot of floor space per bird is sufficient. However, if you want to raise layers, you will require about 2 square feet of floor space per bird for the egg-type birds, and $2\frac{1}{2}$ to 3 square feet per bird for the dual-purpose birds.
2. **Draft-Free Ventilation** - An adequate amount of air movement through the poultry house is important for a variety of reasons: It supplies the birds with oxygen; prevents the buildup of carbon dioxide and ammonia, which in excess is harmful; and helps to regulate temperature. Good ventilation is also needed to remove excess moisture, in order to keep the litter dry and to help control diseases.

The amount of ventilation required depends upon the season and the age of the birds. During the winter months, ventilation is necessary, but it is equally important to keep the birds away from drafts. The best arrangement for winter ventilation is to tightly close three sides and provide openings on the south wall of the house. The openings should be fairly high in the wall, since moist air is light and rises toward the ceiling. The openings should be covered with burlap in severe cold weather. When the weather is very warm, the birds need plenty of fresh air to keep cool. Cross-ventilation becomes very important, and therefore, windows should be completely removable. The openings should be covered with a $\frac{3}{4}$ -inch mesh netting to keep sparrows outside.

It is important to remember that young birds are much more sensitive to drafts than older birds.

3. **Light** - For the first 48 hours, give your chicks 24 hours of light so that they can find the feeders and waterers. One 25-watt light bulb will provide enough light for a 10 by 10-foot house. Once the chicks have found the feeders and waterers, you can take advantage of natural daylight.

Having windows on the south side of the house will allow more sunlight to enter the house. Clean the windows once a week to give maximum light. Covering the inside of the windows with a wire mesh screen will prevent the birds from flying into the windows and breaking them. When the weather is warm, remove the windows to improve air circulation.

4. **Temperature** - Young chicks are unable to maintain their body temperature without an additional heat source. A brooder is a device used to produce heat to protect the chicks from the cold. The temperatures at which chicks are comfortable vary with the age of the chicks, and are as follow:

Temperature	Age of Chicks
95 °F	1 day to 1 week
90 °F	1 week to 2 weeks
85 °F	2 weeks to 3 weeks
80 °F	3 weeks to 4 weeks
75 °F	4 weeks to 5 weeks
70 °F	5 weeks to 6 weeks

At 6 weeks of age, the birds should be well-feathered and supplemental heat is no longer needed.

A couple of thermometers will help you to know when the temperature is right. Hang one just under the edge of the brooder about 2 inches from the floor. Place the other some distance away from the brooder so that you can tell whether you are keeping the brooder at the right temperature.

It is extremely important to have a reliable heat source. Gas and electric brooders, infrared heat lamps, and even ordinary light bulb brooders are all good sources of heat. The type of brooder you select will depend upon convenience, installation costs, and operating costs.

Brooder for 25 to 50 Chicks

A brooder heated by an electric light bulb can be used to brood 25 to 50 chicks. To adjust the temperature in the unit, change the bulb size.

If you are raising 100 or fewer chicks, then one 250-watt infrared lamp may be preferred because the initial cost is very low, and the unit is convenient to use. Infrared bulbs are made of hard glass and have built-in reflectors. The hard glass (pyrex-type) lamps are not as likely to shatter if water splashes on them as the non-pyrex-type lamps are. Infrared brooders are available commercially, or you can build a unit using the following guidelines. Be sure the lamp is equipped with a porcelain socket; plastic ones will not withstand the heat. The electric cord, switch, and plug should all be rated well above the total 250 wattage passing through the system. Suspend the infrared bulbs by an adjustable chain 18 inches above the floor. Watch the chicks carefully to see if they are comfortable. Remember that with an infrared lamp, you are heating the chicks only and not the air temperature, so air temperature measurements cannot be used as a guide to chick comfort.

When the brooder temperature is:

1. Just Right - A contented peep and evenly distributed chicks indicate comfortable conditions.
2. Too Cold - If too cold, the chicks will chirp and pile up under the brooder.
3. Too Drafty - When the chicks chirp and form a wedge, there is a draft.
4. Too Hot - If the chicks move away from the heat source and are drowsy, the temperature is too warm.

Brooder Guards and Litter

A brooder guard is a circular fence designed to keep the chicks from wandering from the heat and getting chilled. It also eliminates corners to avoid piling and shields the chicks from drafts. Keep the chicks close to the brooder by placing the brooder guard 2 or 3 feet outside the edge of the brooder. After 7 to 10 days the guard can be removed. Brooder guards can be made from an assortment of materials, but 12-inch-wide corrugated paper is the best.

Cover the floor of your pen with 3 inches of clean, dry litter. The litter will keep the floor dry, warm, and odorless and prevent a buildup of disease-producing organisms. Wood shavings and sawdust are the most popular litter materials used; but other materials such as crushed cane, crushed corn cobs, or chopped straw work just as well. Stir the litter frequently to keep it dry and loose. Occasionally add fresh litter until it is 4 to 6 inches deep.

5. **Easy Access to Feed and Water** - Seventy percent of the cost of raising chickens is due to feed cost. This is an investment rather than an expense, because the better the birds are fed, the greater the return in eggs and/or meat. Make sure the birds always have plenty to eat. Never fill the feeders more than half full; otherwise you will be wasting feed and money.

Water is the cheapest nutrient, yet it is often the most neglected. Water softens the feed and aids digestion. It serves as a carrier of waste products, is involved in temperature regulation, and acts as a lubricant in body tissues.

Give day-old chicks 8-percent sugar water to drink (1½ cups of sugar per gallon of water) for the first day. The sugar serves as a quick and easy-to-use energy source for thirsty

chicks. If possible, give the water to the day-old chicks 3 to 5 hours before giving the feed. This will get the chicks off to a good and healthy start.

When selecting waterers and feeders, keep in mind that chicks grow fast; feeding and watering space and the size of the equipment need to increase to meet their needs. Chicks develop both a scratching and roosting behavior, which can lead to feed being scattered over the litter, and to having droppings in the feed if the birds are permitted to perch on the feeders.

It is also important to remember that the sooner the chicks are placed in the brooder house and allowed to eat and drink, the better their growth and performance. For the first few days place the feed in feeder trays. A cardboard box, cut off to 2 inches high makes an excellent feeder tray. Add some small chick feeders, and gradually remove all the feeder trays. Make sure the chicks have found the regular chick feeders before removing all the trays. Use chick-size feeders for the first 2 weeks.

Provide 1 inch of feeder space per chick, counting both sides of the feeder. For example, if your chick feeder is 12 inches long, then it can handle 24 chicks.

From the second week on, tube-type feeders can be used. These are more convenient and more practical than the trough feeders. The tube-type feeders are suspended from the ceiling and can be easily raised, keeping up with the height of the growing birds. These feeders should be adjusted to the height of the birds' backs. To determine the linear space of a round feeder, multiply the base diameter of the container by 3.14. For birds aged 2 to 6 weeks, provide 2 inches of feeder space per bird.

If you intend to use only trough feeders for your birds, the feeders should increase in depth, breadth, length, and height as the birds grow. From the second through the 6th week, use the medium-sized feeders, and provide 2 inches per chick.

Chicks should always have plenty of clean, fresh water. Use six 1-quart fountain-type waterers per 100 chicks during the first week. Replace at the end of 1 week with two 2-gallon waterers. It is a good practice to place the water fountains upon frames 2 feet square made of 1 by 2-inch boards covered with $\frac{1}{2}$ -inch mesh hardware cloth. This will help to keep the waterers clean and the birds away from the damp litter surrounding the water fountain. From the 4th week on, provide two 5-gallon waterers for each 100 birds. Place waterers on wire bottom stands made of 1 by 4-inch boards.

Poultry Nutrition

The commercial poultry feeds available today are the result of years of research. The rations contain 30 or 40 ingredients and are designed to meet the specific needs of the birds. Young chickens or broilers grown for meat are fed differently from pullets raised for their eggs. Because the nutrient requirements vary with the age of the birds, feed manufacturers produce a starter and finisher ration for broilers and a starter, grower, and layer ration for chickens intended for laying eggs.

Feed chicks a starter ration from the very first day, and keep them on the starter until they reach 6 weeks of age. The starter diet has the most protein. As the birds mature they need a lower percentage of protein and higher level of energy.

Once the chicks are 6 weeks old, give them either a finisher diet (to broilers) or a grower diet (to pullets or cockerels saved for breeding purposes). Feed broilers a finisher diet until they weigh about 4 pounds, and then process. Feed the pullets and cockerels a grower until they reach 20 weeks of age or until the pullets start to lay eggs. When egg production begins, feed them a layer ration.

The minimum requirements for protein, calcium, and phosphorus in poultry feeds are given in Table 10. This table should help you to determine what type of feed to purchase for your birds.

The most common mistake made is feeding the wrong feed. Do not give your chickens scratch grain or table scraps. Do not mix a complete commercial ration with scratch grains. Cracked corn, for example, is low in protein. By mixing cracked corn with a complete commer-

Table 10. Minimum Protein, Calcium, and Phosphorus Requirements for Broilers, Pullets, and Laying Hens.

	Protein %	Calcium %	Phosphorus %
Broilers			
Starter	23	0.9	0.5
Finisher	20	0.8	0.5
Pullets			
Starter	20	0.9	0.5
Grower	17	0.8	0.5
Laying Hens			
Layer	16-18	3.0	0.5

cial grower ration, you reduce the protein level, as well as the vitamin and mineral content of the diet. The birds will not grow as well. They will be less resistant to disease, and the birds will pick and eat their feathers trying to compensate for the missing protein. Feather picking will lead to cannibalism.

The second most common mistake made is not feeding enough. During the first 20 weeks, you can expect each dual-purpose-type pullet to eat about 20 pounds of feed. Table 11 shows you the amount of feed you will need to buy for your poultry project.

Table 11. Amount and Kind of Feed Required for 25 Pullets by Age

Age	Amount and Kind of Feed
0-6 weeks	100 lbs. of starter
6-20 weeks	400 lbs. of grower
Once laying starts	100 lbs. of layer every 2 weeks

When you buy feed, you may have the option of buying a non-medicated feed or a medicated feed. Poultry feeds which are medicated are used to prevent or treat disease. The two most common medications added to feeds are coccidiostats and antibiotics.

Coccidiostats are drugs that are added to feed at low levels and fed continuously to prevent a disease called coccidiosis. Coccidiosis is a disease of the intestinal tract, caused by microscopic single-celled animals called protozoa. Birds having this disease may appear sleepy, pale, ruffled, and unthrifty. They may also have bloody droppings. Broilers are fed a ration containing a coccidiostat until the last week before processing. An unmedicated feed is fed this last week. Young chickens intended for laying eggs are also susceptible to coccidiosis. They should receive a coccidiostat until they are about 16 weeks of age. The medicated feed is then replaced with a non-medicated feed. Older chickens are more resistant to coccidiosis; however, if an outbreak does occur it can be controlled by treating the water with a coccidiostat.

Poultry feeds may also contain some antibiotics. They are usually added at low levels to prevent minor diseases and to improve the growth performance of broilers. Higher levels of antibiotics are used to treat certain diseases. They are usually given in the water.

Always remember to read the labels on medications, and always follow the instructions and recommended withdrawal periods before eating meat or eggs from treated birds.

Disease Prevention

The first step in raising chickens is to start with healthy chicks. Then it is up to you to provide clean, comfortable housing for the birds. Use preventive management to avoid disease and parasite problems.

Start with a clean house and equipment. If the house was used earlier, scrub the house with a commercial disinfectant such as creosol or with hot lye water (1 pound of lye to 10 gallons of hot water). Let the house dry several days before placing the chicks in the house. Disinfect waterers and feeders with a quaternary ammonium solution. Wear protective clothing, gloves, and goggles while using creosol or lye.

Keep feed in metal cans with tight lids to keep mice and rats out. Repair holes in screen windows to prevent birds and small animals from entering the house.

Remove sick or dead birds from the poultry house as soon as they are found. Dispose of dead birds promptly by burying them deeply to discourage animals from digging.

Prevent cannibalism and feather picking by buying chicks that have been beak trimmed at the hatchery, or clip off the tip of the beak with a dog's toenail clippers. Overcrowding, nutrient deficiencies, poor ventilation, too little drinking and eating space, too much light, and the appearance of blood on an injured bird are factors which lead to picking.

External Parasites

Mites and lice are the most common parasites found on chickens. Consult your county Extension agent for advice on pesticides safe to use on or around poultry. Carefully follow instructions when using pesticides.

Internal Parasites

The large roundworm can become a problem for small flocks. A few worms do not cause any harm, but if you see worms in the droppings, you need to treat the birds. Your county Extension agent can recommend a worming compound.

Vaccination

The hatchery can vaccinate the chicks against Marek's disease. The protection given by the vaccine is well worth the added cost. Marek's disease is caused by a virus. It may result in weight loss, paralysis of legs or wings, and sudden death.

Although it is difficult to secure small lots of vaccine, it may be necessary to vaccinate your flock against fowl pox, Newcastle disease, and bronchitis if these diseases have been a problem in previous flocks. See Table 12 for a suggested vaccination schedule.

Fowl pox is caused by a virus and shows up as blisters and scabs on the combs and wattles. Newcastle disease and bronchitis are viral respiratory diseases.

If you do not vaccinate, do not allow visitors around your flock. Birds that are entered in poultry exhibits may be exposed to disease. Sell the birds or keep them separate from the rest of the flock for at least 2 weeks after their return home. If the birds have picked up a disease, it will appear before the birds are returned to the flock.

Table 12. Vaccination Schedule Indicating Type of Vaccine, Age to Vaccinate, and Method of Vaccination

<u>Vaccine</u>	<u>Age of Bird</u>	<u>Method</u>
Newcastle-Bronchitis	10 days	water
Newcastle-Bronchitis	6 weeks	water
Fowl Pox	12 weeks	wing stab
Newcastle-Bronchitis	4 months	water

Growing Pullets

The growing period follows the brooding period. It begins when the birds are about 6 weeks old and lasts until the pullets are ready to lay. Good management is very important at this time. The care you give your birds now will determine how many eggs you will collect later on. You should practice the following management techniques.

1. **Space** - Each pullet should have plenty of room to grow. Egg-type birds, such as Leghorns, need about 2 square feet of floor space per bird. The larger dual-purpose birds, such as the Black Sex Link or Rhode Island Red, require about 2¹/₂ to 3 square feet per bird.
2. **Draft-Free Ventilation** - Starting a flock in March or April means that the weather should be warm and mild when the birds are 12 weeks of age. Pullets need lots of fresh air. Open the windows during the day to get good cross-ventilation. If the nights are still cool, adjust the windows to avoid drafts.
3. **Lighting** - Take advantage of natural daylight. Do not use artificial lights until the pullets start to lay.
4. **Temperature** - If you have managed your flock well during the brooding period, the birds should be well-feathered and do not require heat. However, cold temperatures at night may make it necessary for you to provide additional heat during the early growing period. Remember to keep your birds as comfortable as possible.
5. **Access to Feed and Water** - From 6 to 12 weeks of age, allow 3 inches of feeder space per bird. Your pullets should have feed available at all times. When adding feed to the feeder, push all the remaining feed to one end. Do not put fresh feed on top of the old feed. Never fill the feeder over half full.
6. **Roosts** - Equip your house with roost poles for the birds to perch on at night. Roost poles can be made from 2-inch stock with slightly rounded upper edges. Roost poles should be spaced 13 to 15 inches apart. They should provide 8 to 10 inches of space per bird. Wire netting at the ends and underneath the roosts will prevent the birds from getting into droppings under the roosts.

Managing Layers

Much of what you have already learned in the poultry project applies to the care of birds 20 weeks and older. The brooder and rearing quarters can be used as the laying house or the ready-to-lay pullets can be moved to a separate house. In either case, be sure to consider the following management factors.

1. **Space** - Plan on each bird having available at least 3 square feet of floor space.
2. **Ventilation** - The amount of ventilation needed depends upon the season. During the summer, keeping hens cool is very important. If you can open up two sides of the house, you will increase air movement. During cold weather, ventilation should be from the south side of the house. Openings that drop down from the top or tip in are best.
3. **Light** - When raising chickens for egg production, it is recommended that the house have artificial lighting. The lights are used to provide a uniform period of light stimulation, not to give the hens more time to eat. It is through the stimulation of light that the ready-to-lay pullet reaches early sexual maturity and begins to lay more eggs. Ready-to-lay pullets need about 14 hours of light daily. Chicks hatched in the spring receive an adequate amount of natural light during the brooding and growing phase. However, due to the decrease in day length in the fall and winter, it is necessary to extend the daylight hours with artificial light. The ready-to-lay pullets should be given extra light beginning in September, and this should be continued until the natural day length reaches 15 hours. The lights may be turned on in the morning at 6:00 a.m. for 2 hours and then turned on again in the evening at 6:00 p.m. until 8:00 p.m. It is sometimes difficult to get up early and turn the lights on or to turn the light off at night. An inexpensive time clock set to control the lights automatically will generally give the best results.

4. **Temperature** - Laying birds do not need artificial heat unless the house is poorly insulated. Keep the house free from drafts. Thaw waterers promptly if they become frozen, or use an immersible water heater to keep the water from freezing. If the birds are exposed to extreme cold, the birds will stop laying, and their combs and wattles may freeze. In the summer, the poultry house should have at least 3 inches of dry litter. When the weather starts to get colder, gradually add fresh litter until it is at least 4 to 6 inches deep. The built-up litter provides a warm, dry floor. Stir the litter often to keep it in good shape. If an area becomes caked or wet, clean out the wet litter and replace with fresh.
5. **Access to Feed and Water** - Your flock should always have a fresh supply of commercial laying mash on hand. Water is very important to the laying flock. Without fresh, clean water, the birds will not eat and will go out of production.
6. **Roosts** - Check the wire mesh around the roosts and make sure the wire is not broken. Sharp points on the wire can injure the foot pads of the chickens and cause infection.
7. **Nests** - Provide one nest for every four hens. Keep clean nesting material, such as wood shavings, in the nest at all times. Place nests 18 to 20 inches above the floor. Individual nests should be 10 to 14 inches wide, 12 to 14 inches high, and 12 inches deep. Perches below the entrance help keep the nest clean.

Egg Care

Most eggs are laid with a clean shell. To keep eggs clean, change the nesting material often. Gather the eggs at least twice a day. Dirty eggs should be buffed clean with emery cloth.

Eggs should be kept in the refrigerator until used. For more information on grading eggs, ask your county Extension agent.

Culling

Culling is the removal of sick or injured birds from the flock. Culling, if done right, will reduce feed costs and may prevent the spread of disease. Culling is a daily task. Separate sick or injured birds from the flock as soon as you see them. Try to learn the cause of the problem before disposing of the bird. The information may be useful in preventing other birds in your flock from getting sick.

Toward the end of the first year of production, some hens may stop laying. You may wish to pick out these loafers, and process them for home use. It is easy to tell the difference between good layers and poor layers once you have learned what to look for.

Good Layers Have:

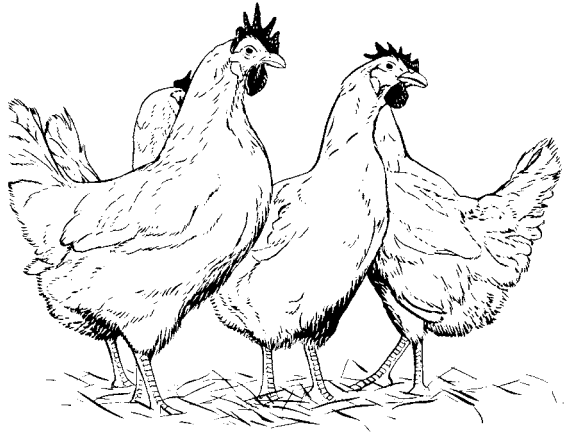
- A bright red comb
- A soft, pliable abdomen
- A large, moist vent
- 3 to 5 fingers' spread between pelvic bones

Poor Layers Have:

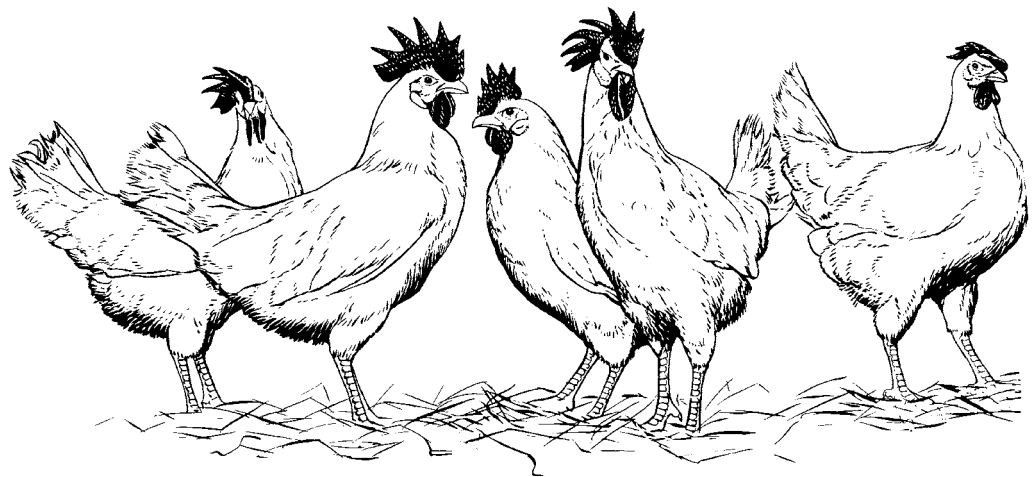
- A dull, shriveled comb
- A hard, fatty abdomen
- A small, round, dry vent
- 1 to 2 fingers' spread between pelvic bones

It is normal for hens that have been laying for 12 to 14 months to take a rest. You can now decide to either process the flock for meat and make room for new pullets or keep the hens for another production cycle.

Acknowledgments: Agricultural Extension Service, University of Tennessee



Breeds, Varieties, and Strains



BREEDS, VARIETIES, AND STRAINS

This is a brief description of the breeds, varieties and strains of chickens and in no way takes the place of the American Poultry Association Standard or the American Bantam Standard.

Chickens exist in many colors, sizes, and shapes. There are more than 350 combinations of physical features. In order to be able to identify and classify each of these, we have established a system of designations known as classes, breeds, and varieties.

A class is a group of breeds originating in the same geographical area. The names themselves indicate the region where the breeds originated, such as Asiatic, Mediterranean, or American. The breeds of chickens in this chapter are arranged first according to their class, and then alphabetically by breed name within each class. Lesser known classes, breeds, and varieties are at the end of the text.

Breed means a group, each of which possesses a given set of physical features, such as body shape or type, skin color, carriage or station, number of toes, and feathered or non-feathered shanks. If such an individual is mated to one of its own kind, these features will be passed on to the offspring.

Variety means a sub-division of a breed. Differentiating characteristics include plumage color, comb type, or presence of a beard and muffs. Examples exist in almost all breeds. In Plymouth Rocks, there are several colors, including Barred, White, Buff, and Partridge. In each case the body shape and physical features should be identical. The color is the only difference and each of these colors is a separate variety. Another example is the Leghorn breed where most varieties exist in Single Comb and Rose Comb with all features other than comb type being identical.

Strains are families or breeding populations possessing common traits. They may be subdivisions of a breed or variety or may even be systematic crosses. However, a strain shows a relationship more exacting than that for others of similar appearance. Strains are the products of one person or one organization's breeding program. Many commercial strains exist. Such names as DeKalb, Hyline, Babcock, and Shaver are organizations that have bred specific strains of chickens for specific purposes.

Most of the breeds and varieties we know in the United States today were developed between 1875 and 1925. During that time the emphasis throughout the poultry world was on breeds and varieties. Success was measured in terms of the excellence of individual birds. As

The commercial egg and poultry meat industries developed, the emphasis changed from the individual bird to the average for the entire flock. This caused some breeders to adopt intensive selection programs based on the performance of certain outstanding families while others worked with breed crosses and crosses of strains within a given breed. Today the commercial poultry industry is based almost 100 percent on the strain approach. However, foundation breeders are constantly looking for additional material for gene pools. This must come from fanciers and hobbyists who maintain the various breeds for personal and aesthetic reasons rather than strictly for the production of meat and eggs.

The American Poultry Association issues a book called *The American Standard of Perfection*. This book contains a complete description of each of the more than 300 recognized breeds and varieties. Such things as size, shape, color, and physical features are described and illustrated in detail.

For more information on chicken breeds, consult *The American Standard of Perfection*, American Poultry Association, and *The Bantam Standard*, put out by the American Bantam Association.

BANTAMS

Bantams are the miniatures of the poultry world. The word bantam is the overall term for the more than 350 kinds of true breeding miniature chickens. They exist in almost every breed and variety that we see in large chickens. In addition, there are some kinds of bantams that have no large counterpart. The term "Banty" or "Bantie" is often used to describe any nondescript, undersized chicken. This is misleading. Bantams are not unhealthy miniatures. They are raised

primarily for exhibition, a purpose for which they excel. The American Bantam Association issues a book of standards for bantams and licenses persons qualified to judge them at exhibitions.

Bantams have the same requirements for shape, color, and physical features as do the large fowl. They should weigh about one-fifth of their larger counterparts. They should be referred to by the name of their breed and variety plus the word bantam; for example Buff Cochin Bantams.

Bantams are kept for their beauty, for exhibition, or as pets or companion animals. Their wide array of shapes, colors, and personalities give Bantams broad appeal. However, they can be quite useful for the production of eggs, and their meat is fine-grained and nutritious. Often, bantams can be kept in areas too small for regular chickens. They are, in fact, the “compacts” of the poultry business.

AMERICAN CLASS

Jersey Giants

Varieties: Black, White.

Standard weights: Cock, 13 pounds; hen, 10 pounds; cockerel, 11 pounds; pullet, 8 pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: A very heavy meat-type fowl for heavy roaster and capon production. Fairly good layers. The dark-colored pigment from the shanks tends to move up into the edible portion of the carcass which has hurt the Jersey Giant in commercial circles.

Origin: Developed in New Jersey in the late 1800's, when there was a demand for heavy fowl for capon production, particularly for the New York market. Size was a prime consideration.

Characteristics: Jersey Giants are the largest breed in the American Class. They should be rugged, with an angular shape, single comb, and black (with yellowish tinge) shanks in the Black variety and dark willow shanks in the White variety. Jersey Giants will go broody but are not the best choice for incubating and brooding because of their size. Their tendency to grow a big frame first and cover it with meat later make them a poor fit for today's conditions. The meat yield is disappointing until they are 6 months or older. No fowl with black plumage or dark or willow shanks has ever remained popular in this country for long, although they used to be more widespread. However, good specimens do have an appeal, mainly because of their size.

New Hampshire Reds

Varieties: None.

Standard weights: Cock, 8½ pounds; hen, 6½ pounds; cockerel, 7½ pounds; pullet, 5½ pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: A dual-purpose chicken, selected more for meat than egg production. Medium-heavy in weight, it dresses a nice, plump carcass as either a broiler or a roaster.

Origin: New Hampshires are a relatively new breed, having been admitted to the Standard in 1935. They represent a specialized selection out of the Rhode Island Red breed. By intensive selection for rapid growth, fast feathering, early maturity, and vigor, a different breed gradually emerged. This took place in the New England states, chiefly in Massachusetts and New Hampshire from which the breed takes its name.

Characteristics: They possess a deep, broad body, grow feathers vary rapidly, are prone to go broody, and make good mothers. Most pin feathers are a reddish buff in color and, therefore, do not detract from the carcass appearance very much. The color is a medium to light red and often fades in the sunshine. The comb is single and medium to large in size; in the females it often lops over a bit. These good, medium-sized meat

chickens have fair egg-laying ability. Some strains lay eggs of a dark brown shell color. New Hampshires are competitive and aggressive. They were initially used in the “Chicken of Tomorrow” contests, which led the way for the modern broiler industry.

Plymouth Rocks

Varieties: Barred, White, Buff, Partridge, Silver Penciled, Blue, Columbian.

Standard weights: Cock, 9½ pounds; hen, 7½ pounds; cockerel, 8 pounds; pullet, 6 pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: Meat and eggs.

Origin: Developed in America in the middle to latter part of the 19th century. The barred variety was developed first. It was noted for its meaty back, and birds with barred feathers brought a premium on many markets. Most of the other varieties were developed from crosses containing some of the same ancestral background as the barred variety. Early in its development, the name Plymouth Rock implied a barred bird, but as more varieties were developed, it became the designation for the breed.

Characteristics: Plymouth Rocks are a good general farm chicken. They are docile; normally will show broodiness; and possess a long, broad back, a moderately deep, full breast, and a single comb of moderate size. Some strains are good layers while others are bred principally for meat. White Plymouth Rock females are used as the female side of most of the commercial broilers produced today. They usually make good mothers. Their feathers are fairly loosely held but not so long as to easily tangle. Generally, Plymouth Rocks are not extremely aggressive and tame quite easily. Some males and hens are big and active enough to be quite a problem if they become aggressive. Breeders should be aware of the standard weights and not select small or narrow birds for the breeding pen. Size is a definite breed characteristic and should be maintained. Common faults include shallow breast, high tails, narrow bodies, and small size.

Rhode Island Reds

Varieties: Single Comb, Rose Comb

Standard weights: Cock, 8½ pounds; hen, 6½ pounds; cockerel, 7½ pounds; pullet, 5½ pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: A dual-purpose medium-heavy fowl, used more for egg production than meat because of its dark-colored pin feathers and its good rate of lay.

Origin: Developed in the New England states of Massachusetts and Rhode Island, early flocks often had both single and rose combed individuals because of the influence of Malay blood. It was from the Malay that the Rhode Island Red got its deep color, strong constitution, and relatively hard feathers.

Characteristics: Rhode Island Reds are a good choice for the small flock owner. Relatively hardy, they are probably the best egg layers of the dual-purpose breeds. Reds handle marginal diets and poor housing conditions better than other breeds and still continue to produce eggs. They are one of the breeds where exhibition qualities and production ability can be successfully combined in a single strain. Some Red males may be quite aggressive. They have rectangular, relatively long bodies, typically hard red in color. Avoid using medium or brick red females for breeding because this is not in keeping with the characteristics of the breed. Also, do not breed from undersized birds or birds with black in their body feathers (called “smut”). Black in the main tail and wing feathers is normal, however. Most Reds show broodiness, but this characteristic has been partially eliminated in some of the best egg production strains. The Rose comb variety tends to be smaller but should

be the same size as the Single Combed variety. The red color fades after long exposure to the sun. (A breed of similar size and type to that of the Rhode Island Red has been developed. It has pure white feathering and is known as Rhode Island White.)

Wyandottes

Varieties: White, Buff, Columbian, Golden Laced, Blue, Silver Laced, Silver Penciled, Partridge, Black.

Standard weights: Cock, 8½ pounds; hen, 6½ pounds; cockerel, 7½ pounds; pullet, 5½ pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: Meat or eggs.

Origin: The Silver Laced variety was developed in New York State and the others in the North and Northeastern States in the latter part of the 19th century and early 20th century.

Characteristics: Wyandottes are a good, medium-weight fowl for small family flocks kept under rugged conditions. Their rose combs do not freeze as easily as single combs and the hens make good mothers. Their attractive “curvy” shape, generally good disposition, and many attractive color patterns (varieties) make them a good choice for fanciers as well as farmers. Common faults include narrow backs, undersized individuals, and relatively poor hatches. Also, it is common to see single combed offspring come from rose combed parents. These single combed descendants of Wyandottes should not be kept as breeders.

Less Popular Breeds in the American Class

Buckeyes: A dark red, muscular bird with pea comb, closely held feathers, and broad shoulders. No varieties.

Chanteclers: Developed in Canada as a dual-purpose farm chicken, they have muscular bodies, small combs (pea) and wattles, and lay brown eggs. Varieties: White, Partridge.

Delawares: A nearly white, rapid growing, dual-purpose fowl developed to figure into broiler crosses, with single comb and brown egg shells. No varieties.

Dominiques: America’s oldest breed. They are rather indefinitely barred black and white, have rose combs, and are relatively small, with tightly held feathers. No varieties.

Hollands: Developed in the 1930’s and ’40’s in an attempt to provide a medium-sized fowl with good meat properties that laid white-shelled eggs. Varieties: Barred, White.

Javas: A medium-sized, angular bird which was a common farm chicken in the United States in the 19th century. Javas possess single combs. Varieties: Black, Mottled.

Lamonas: Lamonas have single combs, appear short-legged, and are one of the few chickens with red ear lobes that lay white-shelled eggs. No varieties.

ASIATIC CLASS

Brahmas

Varieties: Light, Dark, Buff.

Standard weights (Light): Cock, 12 pounds; hen, 9½ pounds; cockerel, 10 pounds; pullet, 8 pounds.

Standard weights (Dark and Buff): Cock, 11 pounds; hen, 8½ pounds; cockerel, 9 pounds; pullet, 7 pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: A heavy fowl for the production of heavy roasters or capons. Fair egg layers.

Origin: The ancestry of the Brahma dates back to China, although much of their development took place in the United States between 1850 and 1890.

Characteristics: Good Brahmas are beautiful, stately birds. Their large size and gentle nature combined with intricate color patterns make them favorites for the country

estate. The Brahma's appearance in the showroom never fails to command the admiration of one and all. These qualities have made them a favorite with fanciers. Brahmans do go broody and are fairly good mothers. Their small comb and wattles, together with profuse feathering and well-feathered shanks and toes, enable them to stand cold temperatures very well. The relatively slow rate of growth and long time required to reach maturity have caused Brahmans to be passed by as a commercial fowl.

Cochins

Varieties: White, Black, Buff, Partridge.

Standard weights: Cock, 11 pounds; hen, 8½ pounds; cockerel, 9 pounds; pullet, 7 pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: Mainly an ornamental fowl, but their ability as mothers is widely recognized and Cochins are frequently used as foster mothers for game birds and other species.

Origin: Cochins came originally from China but underwent considerable development in the United States and now are found and admired in many parts of the world.

Characteristics: Cochins look like big, fluffy balls of feathers. They are mainly kept as an ornamental fowl and are well-suited to close confinement. The profuse leg and foot feathering makes it desirable to confine Cochins on wet days and where yards become muddy to keep the birds from becoming mired or collecting balls of mud on their feet. They exhibit extremely persistent broodiness, are good mothers, and are intense layers for long periods of time. Because of their feathering, it is necessary to clip some of the feathers or resort to artificial insemination to obtain good rates of fertility.

Langshans

Varieties: Black and White.

Standard weights: Cock, 9½ pounds; hen, 7½ pounds; cockerel, 8 pounds; pullet, 6½ pounds.

Skin color: White.

Eggshell color: Brown.

Use: A general-purpose fowl for the production of meat and eggs. The general shape of the Langshan makes them better suited to roaster and capon use than as fryers.

Origin: Langshans originated in China and are considered one of our oldest breeds.

Characteristics: Langshans enjoyed considerable popularity in the United States during the latter part of the 19th century. Today however, they are primarily an exhibition fowl. They appear to be very tall, with long legs and tails carried at a high angle.

They are active and quick. The black variety has a deep greenish sheen when viewed in the proper light. Many other breeds were created using Langshan blood in the foundation matings. They are a good general breed; females go broody and make good mothers. Their feet and legs are feathered but not as fully as the Cochins or Brahmans. Long legs and narrow body conformation leave much to be desired as a meat bird by today's standards.

ENGLISH CLASS

Australorp

Varieties: Black.

Standard weights: Cock, 8½ pounds; hen, 6½ pounds; cockerel, 7½ pounds; pullet, 5½ pounds.

Skin color: White.

Eggshell color: Brown.

Use: Generally a very good egg producer with a fairly meaty body of intermediate size.

Origin: The Australorp was developed in Australia from Black Orpington stock. It is smaller than the Orpington with a trimmer appearance.

Characteristics: Australorps are black, with an intense beetle-green sheen. They have dark eyes and deep bodies and are very active. They are one of the best dual-purpose fowls, having gained attention in the 1930's and '40's by being one side of the successful Austrawhite cross. This cross of Australorp with White Leghorn became the successor to purebred breeds on many Midwestern farms. Broodiness was a problem with the cross and some markets discounted the tinted eggs they laid. Therefore, it soon fell victim to the inbred hybrid crosses of "Hyline" and "DeKalb." Australorps are good egg producers and hold the world's record for egg production, with one hen having laid 364 eggs in 365 days under official Australian trapnest testing.

Cornish

Varieties: White.

Standard weights: Cock, 10½ pounds; hen, 8 pounds; cockerel, 8½ pounds; pullet, 6½ pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: Developed as the ultimate meat bird, the Cornish has contributed its genes to build the vast broiler industry of the world. Its muscle development and arrangement give excellent carcass shape.

Origin: Cornish were developed in the shire (county) of Cornwall, England, where they were known as "Indian Games." They show the obvious influence of Malay and other oriental blood. They were prized for their large proportion of white meat and its fine texture.

Characteristics: The Cornish has a broad, well-muscled body. Its legs are of large diameter and widely spaced. The deep set eyes, projecting brows and strong, slightly curved beak give the Cornish a rather cruel expression. Cornish males are often pugnacious, and the chicks tend to be more cannibalistic than some breeds. Good Cornish are unique and impressive birds to view. The feathers are short and held closely to the body, and may show exposed areas of skin. Cornish need adequate protection during very cold weather as their feathers offer less insulation than can be found on most other chickens. Because of their short feathers and wide, compact bodies, Cornish are deceptively heavy. Due to their shape, good Cornish often experience poor fertility and artificial insemination is suggested. Cornish are movers and need space to exercise and develop their muscles. The old males get stiff in their legs if they do not receive sufficient exercise. The females normally go broody but because of their very minimal feathers can cover relatively fewer eggs. They are protective mothers but are almost too active to be good brood hens.

Dorkings

Varieties: Silver Gray, Colored, White.

Standard weights: Cock, 9 pounds; hen, 7 pounds; cockerel, 8 pounds; pullet, 6 pounds.

Skin color: White.

Eggshell color: White.

Use: A good, general-purpose fowl for producing meat and eggs. It was developed for its especially fine-quality meat.

Origin: The Dorking is believed to have originated in Italy, having been introduced into Great Britain at an early date by the Romans. Much of its development took place in England, where it gained much acclaim for its table qualities. The Dorking is one of our oldest breeds of chickens.

Characteristics: The Dorking has a rectangular body set on very short legs. It has five toes and has a relatively large comb, thus requiring protection in extremely cold weather. Dorkings are good layers and are one of the few examples of a bird with red earlobes that lays a white-shelled egg. Most Dorking hens will go broody, make good mothers, and are quite docile. Because of their white skin, Dorkings are not as popular in the United States as in Europe.

Orpingtons

Varieties: Black, White, Buff, Blue.

Standard weights: Cock, 10 pounds; hen, 8 pounds; cockerel, 8½ pounds; pullet, 7 pounds.

Skin color: White.

Eggshell color: Brown.

Use: A heavy dual-purpose fowl for the production of both meat and eggs.

Origin: Orpingtons were developed in England in the town of Orpington in County Kent during the 1880's. They were brought to America in the 1890's and gained popularity very rapidly, based on their excellence as a meat bird. As the commercial broiler and roaster market developed, the Orpington lost out partly because of its white skin.

Characteristics: Orpingtons are heavily but loosely feathered, appearing massive. Their feathering allows them to endure cold temperatures better than some other breeds. They are solidly colored, are at home on free range or in relatively confined situations, and are docile. Hens exhibit broodiness and generally make good mothers. Chicks are not very aggressive and are often the underdogs when several breeds are brooded together. They are a good general-use fowl.

Sussex

Varieties: Speckled, Red, Light.

Standard weights: Cock, 9 pounds; hen, 7 pounds; cockerel, 7½ pounds; pullet, 6 pounds.

Skin color: White.

Eggshell color: Brown.

Use: A general-purpose breed for producing meat and/or eggs. One of the best of the dual-purpose chickens, a good all-round farm fowl.

Origin: Sussex originated in the county of Sussex, England, where they were prized as a table fowl more than 100 years ago. They continue to be a popular fowl in Great Britain, and the light variety has figured prominently in the development of many of their commercial strains. Sussex is one of the oldest breeds that is still with us today in fair numbers.

Characteristics: Sussex are alert, attractive, and good foragers. They have rectangular bodies; the speckled variety is especially attractive with its multicolored plumage. Sussex go broody and make good mothers. They combine both exhibition and utility virtues but are more popular in Canada, England, and other parts of the world than in the United States.

Another Breed in the English Class

Red Caps A rare member of the English class, these are characterized by having a large rose comb. They are one of the few breeds with red earlobes that lay white-shelled eggs.

MEDITERRANEAN CLASS

Anconas

Varieties: Single Comb, Rose Comb.

Standard weights: Cock, 6 pounds; hen, 4½ pounds; cockerel, 5 pounds; pullet, 4 pounds.

Use: A small fowl that lays a fair number of rather small eggs.

Origin: Anconas take their name from the port city of Ancona, Italy, where they are said to have originated.

Characteristics: Anconas resemble Leghorns in shape and size. They are small, active, alert, and black with white tipped feathers evenly distributed. Anconas are noisy, good foragers, and considered non-broody. They were once a prime egg-producing breed, but today they are mainly kept as an ornamental fowl.

Blue Andalusians

Varieties: None.

Standard weights: Cock, 7 pounds; hen, 5½ pounds; cockerel, 6 pounds; pullet, 4½ pounds.

Skin color: White.

Eggshell color: White.

Use: An ornamental fowl with fairly good egg-production potential.

Origin: Developed initially in Spain, the breed has undergone considerable development in England and the United States.

Characteristics: Andalusians are small, active, closely feathered birds that tend to be noisy and rarely go broody. Andalusians are a typical example of the unstable blue color we see in the poultry industry. It is the result of a cross of black and white. When two blues are mated, they produce offspring in the ratio of one black, two blues, and one white. These whites and blacks when mated together will produce mainly blues. Andalusians are beautiful when good, but the percentage of really good ones runs low in many flocks because of this color segregation. Hence, they are not widely bred and never in large numbers.

Leghorns

Varieties: Single Comb Dark Brown, Single Comb Light Brown, Rose Comb Dark Brown, Rose Comb Light Brown, Single Comb White, Rose Comb White, Single Comb Buff, Single Comb Black, Single Comb Silver, Single Comb Red, Single Comb Black Tailed Red, Single Comb Columbian.

Standard weights: Cock, 6 pounds; hen, 4½ pounds; cockerel, 5 pounds; pullet, 4 pounds.

Skin color: Yellow.

Eggshell color: White.

Use: An egg-type chicken, Leghorns figured in the development of most of our modern egg-type strains.

Origin: Leghorns take their name from the city of Leghorn, Italy, where they are considered to have originated.

Characteristics: A small, spritely, noisy bird with great style, Leghorns like to move about. They are good foragers and can often glean much of their diet from ranging over fields and barnyards. Leghorns are capable of considerable flight and often roost in trees if given the opportunity. Leghorns and their descendants are the most numerous breed we have in America today. The Leghorn has relatively large head furnishings (comb and wattles) and is noted for egg production. Leghorns rarely go broody.

Minorcas

Varieties: Single Comb Black, Rose Comb Black, Single Comb White, Rose Comb White, Single Comb Buff.

Standard weights: Single Comb Black: cock, 9 pounds; hen, 7½ pounds; cockerel, 7½ pounds; pullet, 6½ pounds. All others: cock, 8 pounds; hen, 6½ pounds; cockerel, 6½ pounds; pullet, 5½ pounds.

Skin color: White.

Eggshell color: White.

Use: Developed for the production of very large chalk-white eggs, the Minorca is today principally an exhibition fowl.

Origin: Developed in the Mediterranean area, they take their name from an island off the coast of Spain. Development may have been as an offshoot of the Spanish breed.

Characteristics: The largest of the Mediterranean breeds, they are long, angular birds that appear larger than they are. They have long tails and large, wide feathers closely held to narrow bodies. Minorcas have relatively large combs and wattles. Good Minorcas are stately, impressive birds and can give a fair return in eggs, although in recent years they have not been intensively selected for that purpose. They are rather poor meat fowl because of their narrow angular bodies and slow growth. Minorcas rarely go broody and are very alert and fairly good foragers.

White-Faced Black Spanish

Varieties: None.

Standard weight: Cock, 8 pounds; hen, 6½ pounds; cockerel, 6½ pounds; pullet, 5½ pounds.

Skin color: White.

Eggshell color: White.

Use: An egg-type bird that has, in recent years, had very little selection for that purpose.

Origin: Coming from Spain, this bird arrived in the United States via the Caribbean Islands. Spanish are the oldest breed of chickens that exist in the United States today. At one time known as “The Fowls of Seville,” they were very popular in the South during the Colonial period.

Characteristics: The large area of snow white skin surrounding the face and wattles makes this breed unique. Actually this is an overdeveloped earlobe. Its color offers a marked contrast with the black plumage and the red comb and wattles. They are considered non-broody and hold their feathers close to their body contours. Spanish are active and noisy. Many birds are below recommended weight, and at this time, most of the population is highly inbred.

Other Breeds in the Mediterranean Class

Buttercups: A small, spritely breed from Sicily, their chief distinguishing feature is their cup-shaped comb. Buttercups are non-broody, lay a fair number of small eggs, and are kept strictly as ornamental fowl.

Catalanas: The Buff Catalana is a medium-sized bird noted for its hardiness. It is not well-known in the United States but is widely distributed through South America. Catalanas come closer to being a dual-purpose breed than any of the other Mediterranean breeds.

CONTINENTAL CLASS

Northern European

Hamburgs

Varieties: Golden Spangled, Silver Spangled, Golden Penciled, Silver Penciled, Black, White.

Standard weights: Cock, 5 pounds; hen, 4 pounds; cockerel, 4 pounds; pullet, 3½ pounds.

Skin color: White.

Eggshell color: White.

Use: An ornamental fowl capable of laying fair numbers of relatively small eggs.

Origin: Hamburgs carry a German name but are generally considered to have originated in Holland.

Characteristics: Hamburgs are active, flighty birds. They are trim and stylish with delicate features and are wild in nature. They forage well and are capable of flying long distances. Although good egg producers, their eggs are often very small.

Campines

There are two varieties of campines, Golden and Silver. Campines are a fairly small, closely feathered breed with solid-colored hackles and barred bodies. They are chiefly an ornamental breed but will lay a fair number of white-shelled eggs and are non-broody. They are thought to have originated in Belgium.

Lakenvelders

An old German breed best known for its color pattern (black hackle and tail on a white body). They are quite small, non-broody, lay white-shelled eggs, and are rather wild and flighty.

Polish

Polish

Varieties: White Crested Black, Non-Bearded Golden, Non-Bearded Silver, Non-Bearded White, Non-Bearded Buff Laced, Bearded Golden, Bearded Silver, Bearded White, Bearded Buff Laced.

Standard weights: Cock, 6 pounds; hen, 4½ pounds; cockerel, 5 pounds; pullet, 4 pounds.

Skin color: White.

Eggshell color: White.

Use: Strictly an ornamental fowl.

Origin: Probably eastern Europe, although they are so old that their history has been obscured.

Characteristics: Polish are an unusual and beautiful breed. They have a crest (some also possess a beard and muffs) and are small, tightly feathered birds, fairly active despite restricted vision due to their large “head gear.” They need plenty of space to avoid damaging each other’s crests by picking. Ice forming in their crests from drinking water can be a problem in colder weather. Sometimes their crests restrict vision and cause them to be easily frightened.

French

Houdans

Varieties: Mottled, White.

Standard weights: Cock, 8 pounds; hen, 6½ pounds; cockerel, 7 pounds; pullet, 5½ pounds.

Skin color: White.

Eggshell color: White.

Use: An ornamental fowl that is also a good egg producer and fairly good as a meat bird.

Origin: Houdans originated in France where they enjoy a good reputation as a high-class table fowl.

Characteristics: Houdans possess a crest, beard, and muffs and have five toes on each foot. Their rectangular bodies are set on fairly short legs. They are one of the better ornamental breeds for general utility use. Because of their crest, they require plenty of space and feed and water containers that prevent them from getting the crest wet and dirty, especially in cold weather. Because of the fifth toe, baby Houdans often walk with a skipping gait.

Faverolles

An interesting breed that combines a beard and muffs with a single comb and feathered legs and feet. Faverolles are a medium-sized breed and fairly loosely feathered, giving them a rather large appearance. They also have a fifth toe on each foot and while chiefly ornamental, do possess some utility characteristics as well.

Crevecoeurs

A very rare, crested breed, solid black in color, Crevecoeurs are strictly an ornamental fowl.

La Fleche

A very rare breed with a pair of spikes in place of a conventional comb. La Fleche are black, of medium size, and very active. They are strictly an ornamental fowl.

ALL OTHER STANDARD BREEDS CLASS

Games

Old English

Varieties: Black Breasted Red, Brown Red, Golden Duckwing, Silver Duckwing, Red Pyle, White, Black, Spangled.

Standard weights: Cock, 5 pounds; hen, 4 pounds; cockerel, 4 pounds; pullet, 3½ pounds.

Skin color: White.

Eggshell color: White or light tint.

Use: Old English Games are strictly an ornamental fowl.

Origin: Old English Games are the modern-day descendants of the ancient fighting cocks.

They are associated with England, but their heritage is almost worldwide and they have changed little in shape or appearance in more than 1,000 years.

Characteristics: A small, tightly feathered bird, Old English Games are very hardy, extremely active, and very noisy. Old English have figured in the development of many other breeds. The mature cocks should be dubbed (have the comb and wattles removed) with a characteristic cut. This is in keeping with their heritage. Old English hens usually show broodiness but are so small and aggressive as well as defensive that they are not always the best choice as mothers. Old English are capable of considerable flight and may revert to a feral (wild) state in some areas. They are the domestic breed most like the old jungle fowl in appearance.

Modern Games

Varieties: Black Breasted Red, Brown Red, Golden Duckwing, Silver Duckwing, Birchen, Red Pyle, Black, White.

Standard weights: Cock, 6 pounds; hen, 4½ pounds; cockerel, 5 pounds; pullet, 4 pounds.

Skin color: White.

Eggshell color: White or light tint.

Use: Strictly an ornamental fowl.

Origin: Modern Games were developed in Great Britain.

Characteristics: A tightly feathered bird with long legs and neck, which give it a tall, slender appearance. The males of the Modern Games should have their combs and wattles removed to enhance their long, slim shape. The feathers of Modern Games should be short, hard, and held very close to their bodies. They do not stand cold weather well because of their short feathers and need plenty of exercise to maintain muscle tone.

Orientals

Malays

Varieties: Black Breasted Red.

Standard weights: Cock, 9 pounds; hen, 7 pounds; cockerel, 7 pounds; pullet, 5 pounds.

Skin color: Yellow.

Eggshell color: Brown.

Use: Strictly an ornamental fowl.

Origin: A very old breed coming from Asia, they have changed little in modern times.

Characteristics: Malays are very tall and appear bold and perhaps cruel due to their projecting eyebrows. They are closely feathered with short feathers and carry their bodies inclined upward with tail low or drooping. They are rugged and have a reputation for vigor and long life. They require exercise to maintain muscle tone and hardness of feather. Most hens will go broody but are not a good choice because their long legs do not fit easily in a nest.

Sumatras

Varieties: None.

Standard weights: Cock, 5 pounds; hen, 4 pounds; cockerel, 4 pounds; pullet, 3½ pounds.

Skin color: Yellow.

Eggshell color: White or light tint.

Use: Strictly an ornamental fowl.

Origin: Sumatras come from the island of Sumatra from which they take their name.

Characteristics: Sumatras are a distinctive fowl which look less like domestic poultry than other chickens. They have rather long tails carried low enough to appear drooping. They have multiple spurs on each leg, dark purple faces, and a high degree of greenish luster on jet black plumage.

Cubalayas

A hardy bird developed in Cuba, they resemble a Sumatra in shape. Cubalayas exist in three varieties and should be considered a strictly ornamental fowl.

Miscellaneous

Sultans

Sultans come from Turkey. They are strictly an ornamental fowl of very distinctive appearance. They have a large crest, muffs and beard, together with profuse feathering of the feet and legs.

Frizzles

While listed in the *Standard of Perfection* as a breed, frizzling is a genetic modification that can be easily introduced into any population of chickens. It causes each feather to curl back toward the bird's head instead of lying naturally pointed toward the tail.

Naked Necks

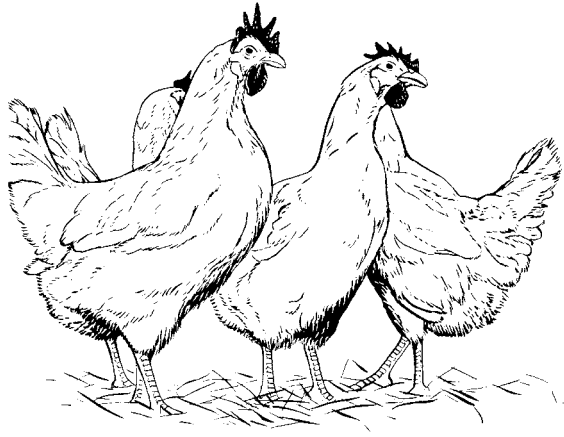
Turkens

The Transylvania Naked Neck is often called Turken. Some people think it is a cross between a chicken and a turkey because of the unfeathered area on the neck. This skin turns red when exposed to the sun, further paralleling the turkey. However, this is actually the result of a single gene that affects the arrangement of feather-growing tracts over the chicken's body. It can be easily introduced into any breed. Turkens have no feathers on a broad band between the shoulders and the base of the skull. They also have a reduced number of feathers on their bodies, but this is not evident until the bird is handled. Turkens should be given protection from extremely cold temperatures as they have far less insulation than their normally feathered cousins. This characteristic is a novel feature that does not detract from the utility of the bird.

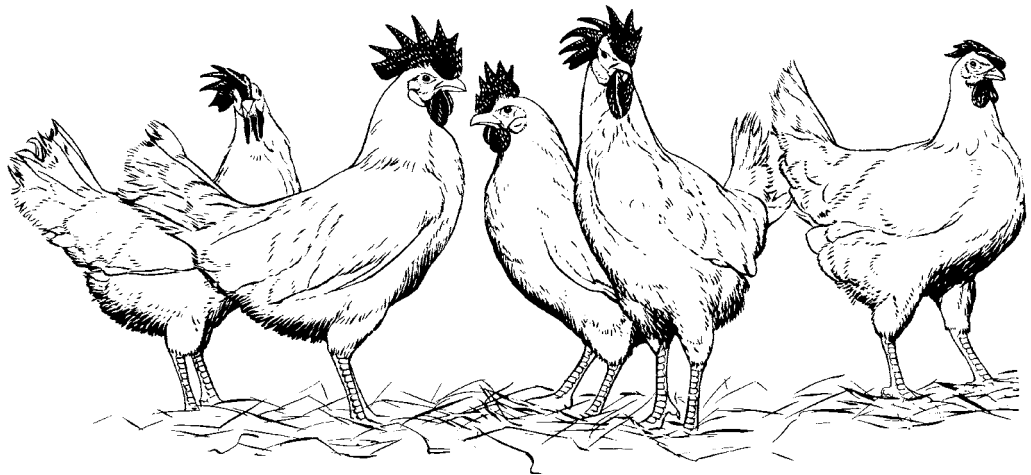
Araucanas

These fowls were discovered in South America. A few were brought to the United States but have been crossed with other chickens so much that characteristics of size, shape, etc., were dispersed. The trait of laying blue or greenish eggs persisted and now breeders are attempting to standardize the physical make-up of the population and gain them recognition as a breed. Some of the Araucanas were rumpless and possessed some interesting ear tufts. Probably at some time in the future, these fowls will be developed into an interesting breed with both economic and ornamental attributes.

Acknowledgments: John L. Skinner, Cooperative Extension Service, University of Wisconsin



Raising Game Birds



RAISING GAME BIRDS

There are many reasons for participating in game bird farming. It can be an enjoyable hobby, a way to fulfill a 4-H project requirement, a means of establishing or increasing game bird populations, or a business venture.

Stocking game birds to establish or increase a resident population for hunting has long been practiced by professional wildlife managers, landowners, and sportsmen. Since public lands available for hunting upland game birds have diminished considerably, many sportsmen are turning to licensed shooting clubs for hunting. Most clubs operate on a put-and-take basis and attempt to harvest a high percentage of stocked game birds.

Whatever your reasons for entering game bird farming, consider these three important factors:

- Game birds must be regarded as a wildlife crop. Proven methods exist to help you raise and harvest a good crop. Game birds are not incidental products that grow without cultivation. You will need to devote enough time to provide the intensive care they require.

- If your motive is to establish or increase local game bird populations, make sure the habitat is suitable for the species being stocked. No animal can survive for long in an unfavorable habitat. Because conditions vary between locations, and game birds differ in their requirements, contact your state Department of Fish and Game or your county Cooperative Extension office for habitat information.

- Every business operates on the principle of supply and demand. If you are considering game bird farming as a business venture, do so only after determining:
 - Present and potential markets and demand
 - Total costs, including initial investment, labor, transportation, and taxes
 - Pricing
 - Competition
 - Contract and supply arrangements

Certain management practices will take most of the guesswork out of planning a successful game bird farming operation, whatever its size or purpose.

RULES AND REGULATIONS

The state Department of Fish and Game is responsible for management of all game birds. Consequently, the rules and regulations are designed to encourage native and certain exotic species while discouraging others. States usually require that a person acquire a game breeder's license before obtaining and keeping game birds. Therefore, direct all questions about legal requirements for any phase of the game bird raising and release to the State Department of Fish and Game.

HATCHING

We strongly recommend that beginners start with day-old chicks or eggs purchased from a reputable game bird breeder who can guarantee a product is reasonably free of disease. A list of game bird breeders is usually available from the State Department of Fish and Game.

Hatchery Equipment

Your need for a hatchery will depend on the size of the operation. Hatcheries should have concrete floors sloped to large drains in every room to facilitate cleaning. Walls and ceilings should be constructed of water-impervious materials.

Hatcheries should be well-ventilated with a system designed to provide a uniform supply of clean air in all areas. The temperature should be maintained between 65 and 80 °F (18.3 and 26.7 °C). In the summer, especially in dry areas, evaporative cooling is preferred, because it increases the humidity of the incoming air. Some heat will need to be provided in most locations during the colder months.

Adequate oxygen levels and carbon dioxide removal are necessary for embryo development, but the main function of ventilation is to control the temperature and to dilute airborne microorganisms during the hatch. In a commercial game bird hatchery, the hatcher and equipment-cleaning area should be in a separate room with its own ventilation system so that the fluff and dust from the hatch are kept away from the incubators, clean eggs, and clean equipment. For small operations, separation of incubator and hatcher may not be feasible.

Some machines are designed to operate better with two or three ages of eggs in one incubator. This makes cleaning more difficult, but you can still clean the interior surfaces of the machine before adding new eggs by removing a few trays at a time, and you can clean the hatcher after each use.

Some incubators have hatchers attached. In these cases, the room should be ventilated so as to keep as much of the dirty air as possible away from the incubator.

When you purchase an incubator or hatcher, select one that is well-constructed. The machine must have automatic temperature control within a narrow range (within +/- .25 °F or 0.15 °C is best). Other essential features for a commercial operation are automatic turning of the eggs, humidity control, and forced air movement.

Another important consideration is the ease of washing and sanitizing the cabinet. Metal or fiberglass surfaces are best. Wood is durable and a good insulator, but it is difficult to clean and nearly impossible to sterilize. Many wooden machines can be improved by coating the interior surfaces with epoxy resin. Do not use lead-based paints; lead is toxic to chicks.

Also consider the reliability of the mechanical systems, the ease of repair, and the availability of spare parts.

Care of Eggs

Always wash your hands thoroughly, preferably with disinfectant soap, before handling eggs. If eggs sweat when removed from the holding room, reduce the humidity or temperature of the room where eggs are trayed. The egg-holding-room temperature may need to be varied as shown in Table 13, depending on the length of egg storage.

Table 13. Holding Room Temperature as Affected by Storage Time

Duration of Storage Days	Maximum Storage Temperature	
	°F	°C
1	70	21.1
2-4	65	18.3
5-10	60	15.6
Over 10	55	12.8

Set only nest-clean eggs. Cracked, thin-shelled, misshapen, or abnormal-size eggs should not be set, because they hatch very poorly and are likely to contaminate other eggs or chicks. Eggs that have been stored do not hatch as early as fresh eggs and therefore should be preset or allowed more time to hatch. Eggs stored for 2 weeks should be preset for 10 hours; those stored for 3 weeks, 18 hours.

Fumigation

Fumigate clean eggs soon after collection and again after traying, if desired, but never between 24 and 96 hours of incubation. Hydrogen peroxide (H₂O₂) is an effective fumigant.

Incubation

Proper incubation is not difficult, but certain procedures should be followed to ensure success. First, clean the equipment. Wash incubators and hatchers with detergent solution, then rinse and fumigate them. Soak trays in detergent solution and then scrub, rinse, and fumigate them with the incubator.

After the incubator is clean, it should be started, tested, and adjusted as necessary before any eggs are set. Operate the machine for 24 hours before setting eggs. Put a record sheet on each machine, and record the wet and dry bulb temperatures at least twice a day. Table 14 specifies conditions for incubation of pheasant, partridge, and quail eggs.

Table 14. Conditions for Incubation of Pheasant, Partridge, and Quail Eggs

Machine Type	Incubation Temperature		Hatching Temperature	
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb
Fan Ventilated	99.5-100 °F (37.5-37.8 °C)	82-86 °F (27.8-28.3 °C)	98.5 °F (37 °C)	90-92 °F (32.2-33.4 °C)
Still Air	102-103 °F (38.9-39.4 °C)	88-90 °F (31.1-33.3 °C)	100-101°F (37.8-38.3 °C)	88-92 °F* (31.1-33.3 °C)

*Wet bulb temperature is not an accurate measure of relative humidity in still-air incubators.

Always follow the manufacturer's instructions for adjusting the air vents in the incubator, but remember that some ventilation is necessary at all times to ensure proper levels of oxygen and carbon dioxide.

Eggs can be set either large end up or horizontally, but never small end up. They should be turned every 2 to 4 hours during the first two-thirds of incubation or until transfer to the hatcher, but never during the hatching period. If mechanical turning is not available, turn eggs three or more times per day (starting as early and finishing as late as possible).

When eggs are set, record the date, egg source, number set, and expected transfer and hatch dates. Attach a card with this information to the setting trays, so that each set can always be easily identified.

Examination of Eggs

Game bird eggs should be candled after 7 to 10 days of incubation and again at transfer (3 to 4 days before hatch). A strong candling light is advisable, because most species have pigmented shells that obstruct light transmission. Remove and count all eggs that are clear or contain blood rings. The eggs that are candled out (or a sample of at least 50) should be opened, examined, and classified before they are discarded.

Egg examination is most conveniently performed in a well-lighted area equipped with a sink and garbage disposal. Open eggs by breaking the large end and removing the shell and shell membranes on this end with the thumb and forefinger. Carefully open eggs that have blood rings to avoid loss of any embryo that might be present near the air cell. As the types are identified, they should be recorded.

The early candling will reveal the following types:

Clears

- True infertiles
- Fertile no development (FND): fertiles that failed to develop
- Positive development (PD): showing cellular development but not blood

Blood Rings

- Blastoderm without embryo (BWE): a blood ring appears but no embryo
- Early dead embryos

After the second candling, the eggs removed should also be examined. Most of these will be dead embryos, but you may occasionally find a live embryo, which should be dropped from the sample count, or one of the previously described types that was missed on the first candling. Record the latter on the record from the earlier candling and examination.

Transfer to Hatcher

Table 15 gives incubation periods of several game birds. Transfer eggs to the hatcher 3 or 4 days before hatch—just before pipping (breaking through the shell) starts. Lower the dry bulb temperature by 1 °F (0.3-0.5 °C) and increase the wet bulb temperature to 88-92 °F (31.1-33.3 °C); this will provide optimum hatching conditions. You may need to vary these wet bulb settings to get the correct moisture content of the eggs. Fumigation in the hatcher is not recommended unless there is a disease problem.

Table 15. Incubation Periods for Several Popular Game Birds

<i>Bird</i>	<i>Days</i>
Chinese Ring-necked Pheasant	23-24
Mongolian Ring-necked Pheasant	24-25
Red-legged Partridge	23-24
Hungarian Partridge	24-25
Bobwhite Quail	23-24
California Quail	23-24
Japanese Quail	17-18
Wild Turkey	28

When the hatch is completed, sort, count, and place the chicks in new chick boxes or plastic boxes that have been cleaned, sanitized, and equipped with new pads. Be sure that you have allowed enough time for the hatch to be completed and the chicks to dry, but don't keep the chicks in the hatcher longer than necessary, because they will become dehydrated. When 1 to 5 percent of the chicks are still wet, it is time to remove the hatch.

Record and break out all unhatched eggs as previously described. Give particular attention to the moisture (dry-down) condition and the embryo position (normal is head under right wing). There are usually some abnormal embryos with missing parts, duplications, or abnormal parts in this group. If there are significant numbers with the same abnormality, be sure to note this.

Keep a record of the results of each hatch, including the information from candling and egg examination as well as the number of chicks obtained. These records are useful in pinpointing problems when hatches are poor. Reasonable goals for most game birds are 96 percent true fertility, 93 percent candled fertility, 87 percent hatch of eggs set, and less than 3 percent cracked and unsettable eggs.

Sanitation

After removing the chicks, thoroughly clean the hatcher and trays. The hatching trays can then be returned to the hatcher and the entire unit fumigated by using the procedure described earlier.

Sanitation is always 90 percent cleaning. Disinfectants are valuable in maintaining a sanitary hatchery, but they will not compensate for a poor cleaning job. Following is a good washing procedure:

1. Empty refuse.
2. Soak in detergent solution, if necessary, to loosen dirt.
3. Wash with hot water and detergent.
4. Rinse.
5. Disinfect (steps 4 and 5 may be combined if disinfectant is nontoxic).

An equipment washing area should be provided near the hatcher(s). A reasonable arrangement for a small hatchery would be as follows:

- Room A: egg processing and traying area, egg holding room, egg fumigation cabinet, incubators, clean equipment storage area.
- Room B: hatcher(s), chick holding area, equipment washing area, outside door to refuse collection area.

BROODING

Artificial brooding of domestic poultry and game birds has been so successful that natural brooding has become obsolete. There are basically two types of brooding in common use: cool-room brooding and warm-room brooding. In the former, birds are provided with a heat source with an adjacent area held at a lower temperature. This system has several advantages including faster feathering in the chicks and easier temperature regulation. With warm-room brooding, a heating system maintains the entire house or room at the desired temperature.

Heat Sources

Many types of heat sources can be used successfully for brooding. These include heat lamps; hot water or steam pipes; or stoves that use natural gas, liquid petroleum (LP) gas, fuel oil, coal, wood, or electricity. Stoves using LP gas or natural gas are the most popular because of their economy and convenience. We recommend the hover-type gas brooder, because it is more economical to operate than the pancake type. With a hover brooder, which has more depth, less heat is lost into the room, and the cooler room temperature stimulates fast feathering in chicks.

With cool-room brooding, the temperature of the hover area is usually adjusted to 95 °F (35 °C) during the first week, and then the temperature is decreased approximately 5 °F (2.8 °C) per week until the room temperature is reached. Measure these temperatures at bird height near the edge of the brooding stove.

The best guide to temperature adjustment is to watch the chicks' behavior. If the temperature is too low, they will huddle under the stove. If they avoid the heated area completely, the temperature is too high.

With warm-room brooding, chicks can be started at a room temperature of approximately 90 °F; this temperature should be decreased as they become older.

Light and Ventilation

It is important that brooding pens be properly lighted during the first week so that young chicks will learn to eat and drink. Use continuous light with an intensity of 2 or more foot-candles during the first week; after that, the light may be reduced to 12 hours per day or natural daylight.

Brooder houses or rooms containing starting batteries need to be well-ventilated to remove moisture and ammonia. If you smell ammonia or observe wet litter in the pen, ventilation is marginal or inadequate. Fans and uniform slot air intakes provide good ventilation in houses with high bird density.

Brooding Methods

Battery brooding has attractive features for some growers. Batteries are particularly suited to small groups of chicks that need to be raised separately. They are easily cleaned, and the chicks are easy to inspect. With larger hatches, battery brooding requires more labor than floor brooding, and chicks must be moved to other pens after 2 or 3 weeks.

For floor brooding, the first step in preparing a pen for new chicks is to clean the area thoroughly, including the walls and ceilings, and clean all of the equipment that will be used in the brooding pen. Then disinfect the brooding area and the equipment using an effective disinfectant. After the pen is disinfected and thoroughly dry, place 3 or 4 inches of clean litter in the pen. Shavings, peanut hulls, rice hulls, sugar cane fiber, ground corn cobs, or chopped straw are excellent litter materials. Sawdust and sand, although sometimes used, are less desirable. Litter should be free of molds and toxic materials.

Place the heating unit in position and cover the floor in this area with rough paper so that chicks can walk on it easily. A brooder ring 15 to 20 inches (37.5 to 50 cm) high, made of corrugated cardboard or $\frac{1}{2}$ -inch (1.25 cm) mesh hardware cloth, should be placed around the heat stove to form a circle approximately 18 inches (45 cm) from the edge of the stove. (For quail, finer mesh hardware cloth would be needed.) The solid corrugated cardboard ring is preferred, because it protects chicks from drafts.

Start the stove and adjust it to the correct temperature at least 1 day before chicks are to be placed under the heating unit. Place feed troughs and water fountains in the brooder ring, and fill them before chicks arrive. Allow at least 20 inches (50 cm) of eating space per 100 chicks. Some feed should also be placed in egg flats or box covers during the first 3 to 5 days to encourage chicks to eat.

Be sure to provide plenty of waterers—at least two 1-gallon (3.78-liter) fountains per 100 chicks—so that chicks will be able to find water quickly. Use watering devices of the right size to prevent chicks from falling into the water reservoir. For quail, it may be necessary to cover the water trough with hardware cloth or to place pebbles in the trough so that chicks can escape when they fall into the water.

Most healthy chicks that die during the first week do so because they fail to learn to drink. It is a good practice to dip the beak of each chick into the water as you remove it from the box and place it in the pen.

Always check young chicks after dark to be certain that none are huddled away from the heat. A light under the stove can help keep chicks under the stove at night.

GROWING GAME BIRDS

The basic principles and techniques for growing birds apply equally to most species of game birds. The successful breeder innovates to fit the needs of the specific operation.

Cages and Pens

Chukars and quail can be grown successfully in all-wire cages kept inside a building. About 1 square foot (0.023 square meter) per bird is adequate for chukars and 2 square feet (0.046 square meter) for quail.

Outside pens for growing or holding breeder stock should be constructed to permit good drainage of water from sprinklers or storms. Pens for growing birds may be of several different sizes, but their actual construction is much the same. Pens used in large commercial production are usually arranged side by side with the ends opening into a central service aisle, which is also covered to prevent escape. The support posts are 4 by 4 inches (10 by 10-cm) of redwood or treated wood placed on 8- or 10-foot (2.4 or 3.0-meter) centers. Occasionally 2 by 4-inch (5 by 10-cm) support posts are used alternately with the 4 by 4-inch (10 by 10-cm) posts.

To provide protection from the wind, the lower walls of pens should be boarded to a height of 20 to 24 inches (50 or 60 cm). The outside perimeter is made predator- and rodent-proof by burying a piece of wire netting 12 inches (30 cm) wide to a depth of 8 inches (20 cm) with the remaining 4 inches (10 cm) turning outward. Pens are commonly enclosed on the top and outsides with 2-inch (5-centimeter) wire mesh. The same size wire mesh can be used for partition between pens.

Commercial game bird growers use pens of various sizes. The number of birds put into the pen depends on pen size and on ground cover (vegetation) available. Twice as many birds can be grown in pens with adequate ground cover as in pens without any ground cover (Table 16).

Table 16. Suggested Pen Size and Bird Density

Species	Pen size		Bird Density sq ft/bird
	Width ft	Length ft	
Pheasant (15 or 30 m)	50 or 100 (45 m)	150 (1.35 sq m)	15*
Chukar (15 or 30 m)	50 or 100 (45 m)	150 (0.93 sq m)	10
Quail (15 m)	50 (45 m)	150 (0.37 sq m)	4

**Double the space required for each species if growing pens do not have adequate vegetative cover.*

The space requirements for growing ornamental pheasants are greater than for other pheasants because of their timid behavior and elaborate feathering. More protection is provided for exotic pheasants, such as the Firebacks, Argus, Peacock pheasants, and Long-tailed pheasants. One arrangement used for exotics is a shed-type house with inside partitions that are continuous with outside runs of 10 by 20 feet (3 by 5 meters).

Cover Crop

A good cover crop helps in obtaining optimum growth and good feathering in game birds; a ground cover or herbaceous growth provides shade and protection. For many ornamental pheasants and some grouse, a selection of different conifer species placed throughout the pens is desirable.

For large or small operations, a number of wild annual grasses serve as excellent ground cover. Some annual weeds, such as pigweed, lambsquarter, millet, mustard, or vetch, grow as volunteer crops and, if properly watered and maintained, can provide excellent cover. Perennials, such as alfalfa, sweet clover, or fescue, require more attention than do most annuals and support fewer birds.

Waterers and Feeders

Waterers must provide a continuous supply of fresh, cool drinking water. Range and bowl founts are popular types used on commercial game farms. It is desirable to have a screened platform or dry well filled with rock beneath the fount to prevent puddling.

Feeders of many designs are used successfully on game farms; the size and type used depend on the farming operation. A good management practice is to keep all feeds covered. Many range feeders are designed with a sloping cover that keeps the feed or grain dry during bad weather. Open trough feeders can be used for grit and shell.

MANAGEMENT OF BREEDER STOCK

To establish a good foundation stock, it is important that the original eggs or stock come from a pullorum-free source. The potential breeder stock should be free of abnormalities (blindness, crooked toes, or malformed beak, neck, or leg bones). The birds should have good body conformation and the size and color pattern characteristic of the species.

Cages and Pens

Pheasants perform satisfactorily when housed in wire colony cages. A mating ratio of 10 hens to 1 cock is recommended in a colony pen measuring 2 feet (0.6 m) wide by 6 feet (1.8 m) long by 1½ feet (0.45 m) high.

Equipment

The same types of feeders and waterers used in the growing pens can be used for the breeders. Adequate covers on the feeders are highly recommended, especially during the wet spring months.

Nest boxes placed in protected areas within the pen greatly reduce the incidence of dirty eggs and prevent bacterial contamination. A wooden nest box 2 feet (0.6 m) wide by 6 feet (1.8 m) long by 1 foot (0.3 m) high, either subdivided into three compartments or constructed as one single walk-through unit, will serve about 24 hens. Place artificial eggs in the nests well in advance of the laying season to encourage the hens to use the nest rather than to lay eggs randomly on the ground. Low shelters placed about the pen serve as shades and escape sites for hens chased by over-aggressive males.

Care of Eggs

Proper handling and care of eggs are extremely important in maintaining hatchability. Store hatching eggs in a cool room maintained at about 50 to 60 °F (10 to 15.6 °C) and 70 percent relative humidity (see Table 1). Following are recommendations for proper care of potential hatching eggs:

- Keep nest areas dry.
- Collect eggs a minimum of three times daily.
- Avoid over-filling the basket when gathering eggs.
- Don't spray insecticides or larvicides around breeder pens or the egg holding room.
- Clean eggs with slightly soiled shells with a light abrasive (sandpaper) material and fumigate soon after gathering. Don't use heavily soiled eggs for hatching. Lightly soiled eggs can also be washed.
- Store eggs to be set within 14 days large end up in open flats. Eggs to be held longer than 14 days should be placed in flats, sealed in new plastic bags after a 24-hour cool down, and turned at least twice a day.

Lighting

Game birds can be induced to lay at any time of the year provided they have been exposed to day-lengths of less than 12 hours for a minimum of 6 weeks before they are given stimulatory light. A series of incandescent lights placed above the breeder pens or pole-mounted outdoor lamps (for example, quartz iodide) can furnish the light necessary to stimulate early egg production. A time clock can be used to control the duration of light.

Some growers use a step-up lighting program: The light-day is increased to 14 hours per day, and once the birds reach peak production, the light increment is increased by 15 minutes per week until a maximum of 17 hours of light per day is attained. Never decrease the light intensity or the number of light-hours per day when egg production is desired.

Hens can be recycled to lay by first restricting the light to hours per day following the regular season. Eight weeks later, expose the birds to a stimulatory light regime of 14 or more hours per day. Hens begin to lay about 18 to 21 days after stimulatory light. Always light males 2 weeks before females to ensure good, early fertility, because males respond more slowly to a stimulatory light regime.

FEEDING GAME BIRDS

It is not essential to buy special game bird diets. Game birds thrive on poultry diets that are properly balanced in energy, amino acids, vitamins, and minerals, similar to the diets given in Table 17. Game bird or poultry diets are usually available in 50- or 100-pound (22.7- or 55.4-kg) sacks.

Game birds can be fed diets in the form of mash, crumbles, or pellets. Pellets and crumbles are made from mash and are more expensive. Pellets are usually fed to adult birds. There is little advantage in feeding pelleted diets to game birds, but they are less dusty to handle.

Never feed laying rations to day-old game birds, because such diets contain high levels of calcium, which can be harmful to the growing chicks. Also, do not feed grain to day-old chicks. After the birds are about 4 weeks old, a part of the diet can be in the form of grain if grit is made available.

Table 17. Composition of Game Bird Diets

Item	Starter %	Grower %	Breeder %
Alfalfa meal	7.5	5.0	5.0
Corn, ground	28.0	52.0	56.7
Meat and bone meal	8.0	0.0	0.0
Sorghum, ground	10.0	0.0	0.0
Soybean meal (45% protein)	28.0	27.5	14.7
Wheat, ground	15.0	0.0	0.0
Wheat middlings	2.0	0.0	0.0
Wheat bran	0.0	12.0	16.8
Limestone, ground	0.0	1.0	4.1
CaHPO ₄ • 2H ₂ O	0.0	1.5	1.5
Salt, iodized	0.7	0.4	0.5
DL-methionine	0.3	0.1	0.2
Premix*	0.5	0.5	0.5
<u>Calculated analysis</u>			
Protein, %	23.4	19.8	15.1
Metabolizable energy (kcal/kg) (or kcal/2.2 lb)	2,720	2,660	2,570
Ca, %	1.0	0.94	2.15
Total P, %	0.76	0.76	0.74
Available P, %	0.52	0.45	0.44

*Premix should contain:

- In mg per kg (or per 2.2 lb) diet: MnSO₄ • H₂O, 40; ZnO, 60; vitamin B₁₂, 0.005; menadione sodium bisulfite, 2; riboflavin, 6; niacin, 40; calcium pantothenate, 20; folacin, 0.5; antioxidant, 100; antibiotic, 10
- In IU—vitamin A, 5000; vitamin D₃, 1500; vitamin E, 20. An equivalent commercial premix can be used, but follow the directions of the supplier.

simplest way to feed game birds is to buy a game bird or turkey starter ration containing about 26 to 28 percent protein and feed it for the first 6 weeks. When the birds are 7 to 14 weeks old, feed a game bird or turkey grower diet or a chicken starter diet containing about 20 percent protein. From the age of 15 weeks until market, feed a game bird, chicken, or turkey growing diet containing about 15 percent dietary protein. When fed such diets, most game birds grow at the rate indicated in Table 18.

A turkey starter mash with 28 percent protein can be used as a diet for small flocks of game birds as shown in Table 19. Breeding birds need a good breeder ration containing about 15 to 16 percent protein. To mix your own game bird diets, use the formulas given in Table 17.

Place grit and mash in separate containers. The size of grit depends upon the size of the bird. The grit should be insoluble in dilute hydrochloric acid. Fine gravel is an acceptable substitute for purchased grit.

Do not store feed for more than 6 weeks at any time, especially in the summer. Protect the feed from rodents and insects. We suggest storing small amounts in metal garbage cans with tight lids. Growers of large flocks will need bulk feed tanks. Keep feeders clean and dry to prevent any mold growth.

Table 18. Growth Rate and Feed Consumption of Some Game Birds (mixed sexes)

Age wk	Ring-necked pheasant		Chukar partridge		Japanese quail	
	Cumulative weight grams*	Cumulative feed consumed grams	Cumulative weight grams	Cumulative feed consumed grams	Cumulative weight grams	Cumulative feed consumed grams
1	41	59	32	32	23	32
2	82	154	54	90	45	65
3	136	286	100	220	73	114
4	195	450	159	368	95	180
5	264	614	210	527	109	255
6	350	865	250	730	118	335
7	436	1160	320	970	127	445
8	523	1455	370	1200	132	570
9	591	1750	504	1430	136	715
10	690	2090	435	1660	136	860
11	775	2520	480	1910	136	1020
12	840	2955	515	2200	141	1195
13	920	3385	527	2490	141	1365
14	1000	3860	545	2720	145	1480
15	1065	4320	550	2945	145	1605
16	1100	4820	568	3135	145	1735
17	1135	5320	577	3325	150	1865
18	1140	5820	590	3520	150	2020

*454 grams = 1 pound.

Table 19. Diets for Small Flocks of Game Birds*

Age	Ratio of turkey starter mash to grain
0-4 weeks	Mash only
5-8 weeks	4 to 1 (80 lb or kg mash to 20 lb or kg grain)
9-12 weeks	3 to 2 (60 lb or kg mash to 40 lb or kg grain)
13-16 weeks	2 to 3 (40 lb or kg mash to 60 lb or kg grain)
17 weeks to market	1 to 3 (25 lb or kg mash to 75 lb or kg grain)

*Feed pasture or green chop free choice, if available, from 4 weeks to market. Feed grit free choice to all birds. For breeders, feed one part mash to one part grain plus free-choice oyster shell, grit, and green chop (if available).

DISEASE CONTROL

Most diseases affecting game birds are caused by microorganisms or viruses spread from bird to bird directly or indirectly. Some infections are airborne; others are transmitted by insects, rodents, free-flying birds, and other animals. Diseases can also be spread by mechanical means, such as tools, beak trimmers, chick boxes, and motor vehicles. Droppings or litter from a previous flock of birds can be a reservoir of disease-producing organisms. The greatest threat to any game bird operation is disease. For this reason, you should enforce the following good management practices at all times:

- Avoid introducing live birds. Live birds are a principal means of bringing disease organisms to susceptible birds. Even though a bird may appear perfectly healthy, it may have had a disease, recovered, and then become a carrier of the disease. If new stock must be introduced, the only relatively safe way is by means of hatching eggs or day-old baby chicks.
- Buy chicks from known sources. Purchase day-old chicks from a breeder with a reputation for producing disease-free stock.
- Separate age groups. Ideally, each species of game bird should be raised separately to eliminate disease and parasite problems. When raising two or more age groups on the same premises is unavoidable, separate the groups as far as possible. During the work day, care for the youngest birds first. Chicks are more susceptible to diseases than older birds.

Vaccination

There is no general rule for vaccination of game birds for specific diseases. Generally, the need for vaccination is determined by the kinds of diseases prevalent in your area. The purpose of a vaccine is to introduce a mild form of a disease into the bird and allow the body to produce antibodies against the organisms, thus building up an immunity. Bacterins (bacterial vaccines) do not produce infections, but will stimulate antibody production.

Sanitation

Preventative disease control is a crucial part of a successful game bird program. Many problems can be avoided if certain management practices are enforced:

- Keep brooder houses and growing pens off-limits to all visitors.
- Train employees to recognize the danger of spreading diseases from farm to farm.
- Thoroughly clean and disinfect all equipment and housing between groups of birds.
- Control predators and rodents, because they may be carriers of disease and external parasites.
- Test breeder stock annually for pullorum as a safeguard against future chick mortality.

Treatment of Disease

Should the birds appear unhealthy and mortality occur, isolate the sick birds immediately. Send a representative sample of sick live birds and some dead birds to the diagnostic laboratory closest to you. Most laboratories charge a small fee for the examination. Treat the sick birds as prescribed by the veterinarian. In acute outbreaks of disease, water medication is preferred over medication in the feed, because sick birds will often drink when they will not eat.

Understanding Diseases

Recognizing common groups of diseases and knowing how they can be prevented or controlled is an important part of a good disease management program.

Parasitic Diseases

Coccidiosis is a destructive protozoan disease that can occur in all species of game birds. It is predominantly a disease of young chicks and is characterized by symptoms of weakness, ruffled feathers, and unthriftiness. Droppings may be bloody. Affected birds are listless and show little interest in feed or water. As the disease advances, moderate to high mortality can be expected. Maintain dry litter and use a good coccidiostat in the feed or water to permit development of immunity in young growing chicks.

Blackhead is a destructive protozoan disease of pheasants, chukars, and grouse. It may spread directly through contact with contaminated feces or indirectly through the infected egg of the cecal worm, *Heterakis*. Infected birds appear droopy, stop feeding, and have a yellowish-brown stool that is watery and foamy. Acutely involved chukars may die very quickly without developing the blackhead syndrome. Several effective drugs are available to prevent or control blackhead.

Worms are often found in game birds at necropsy. Earthworms, slugs, snails, beetles, and other insects are involved in the spread of many parasitic diseases. The best protection against worms is to avoid wet spots around waterers and feeders and to provide well-drained, sloping pens. Phenothiazine and piperazine effectively control some worms.

Acute Infectious Diseases

Erysipelas is a bacterial disease that occurs most often in adult pheasants during the fall. Many deaths may occur before any symptoms are seen. Most affected birds are visibly sick for only a short period before death. General symptoms include weakness, listlessness, loss of appetite, and sometimes a yellowish or greenish diarrhea. Avoid the use of areas previously occupied by swine, sheep, or turkeys.

Fowl cholera generally strikes during the laying season or in mature birds late in winter, and causes very high death loss. It can be introduced onto the farm by wild birds, rodents, and other animals. Treatment consists of prompt cleanup of dead birds and use of antibiotics.

Viral Diseases

Newcastle is a very contagious viral disease, primarily of avian species, including most game birds. Among game birds, Newcastle is transmitted via fecal contamination, eggs, and offal of infected birds. In infected birds, the disease may be manifested by coughing and hoarseness followed by degrees of leg and wing paralysis, tremors, and twisting of the neck. There is no known effective treatment for Newcastle.

Marble spleen disease is a viral disease commonly found in pen-raised pheasants and is characterized by deaths with or without noticeable signs of illness. The most consistent internal symptoms are severe edema (fluid in tissues), enlarged grayish-tan mottled spleens, and inflammation of the lungs. There is no known treatment for this disease.

Quail bronchitis is a severe respiratory disease of quail caused by a virus-like agent. The disease affects young quail and is characterized by rapidly spreading respiratory signs (wheezing, coughing, and sneezing) and mortality ranging from 10 to 100 percent over a period of several weeks.

Fowl pox is a viral infection of most game birds characterized by many lesions (sores) on the skin and mucous membranes of the mouth and upper respiratory tract. Captive pheasants are probably similar to chickens with regard to severity and course of pox infections.

When exposure to these viruses is likely, for example, in areas of high chicken populations, vaccination is recommended. It is advisable to consult a veterinarian or poultry farm advisor before planning a vaccination program.

CONTROLLING CANNIBALISM

Cannibalism is found frequently in most chicken-like species of birds kept in captivity. This vicious habit may start as a mild form of feather or toe picking and develop into a full-scale attack on the flesh of other birds. As a consequence, the game bird industry suffers major economic losses. Birds of all breeds and ages are subject to outbreaks of cannibalism. The pheasant is more prone to cannibalize than are other species of game birds. Some factors contributing to cannibalism include:

Overcrowding. High-density housing brings the birds in close contact with one another. Picking may start as a result of boredom, idleness, and lack of adequate feeder space.

Temperature. Too high a brooding temperature may cause birds to become irate and pick one another.

Light. Bright brooder light increases activity and picking. Less picking occurs when chicks are brooded under natural daylight or artificial light of low intensity (0.5 foot-candle or less at the feed troughs).

Age. Cannibalism occurs in all age groups. Toe, beak, and feather picking are more common among baby chicks; vent, wing, and head picking are forms usually found in older birds.

Sanitation. Poor brooder-house ventilation and sanitation may induce certain irritations of the eyes and nostrils, which become prime targets for picking. Keep litter dry to prevent fecal buildup on the toes of young birds; such buildup can result in loss of toes.

Equipment. Poorly designed feeders and waterers with sharp edges can cause injuries that serve as picking points.

External parasites. Lice or mite infestations can cause itching, irritation, and picking of feathers.

Territorial aggression. Most males become very aggressive during courtship and mating. Conditions of overcrowding in range or small mating pens intensify picking.

Nutrition. The incidence of cannibalism is usually higher in flocks fed rations high in energy and low in fiber. Adding fiber in the form of oats may help reduce picking.

Cannibalism can occur under the most favorable management conditions, so daily observation of the birds' behavior is essential to detect a problem. The following management practices will help minimize problems with cannibalism:

- Provide adequate shelter and ground cover.
- Have adequate floor or pen space for the birds.
- Provide adequate feeder space and waterers.
- Eliminate obstacles from floor or pen that may cause injury.
- Remove dead, sick, or weak birds from the flock immediately.
- Don't introduce a few new birds into an established population.
- Avoid frightening the birds.
- Don't make sudden changes in texture of feed.
- Avoid sudden changes in temperature when moving young birds from brooder house to range.
- Use proper mechanical devices or methods for control of cannibalism:

Lighting: Use dim red or white light in brooder house.

Specs: Reduce picking and egg eating.

Hoods: Several types of hoods can be used during the growing, holding, and breeding period.

Bits: Reduce picking by preventing closure of beak.

Beak trimming: Proper removal of no more than one-third of the upper bill can greatly reduce injury due to picking. Commercial hot-blade beak trimmers used for chickens work equally well for game birds. Heavy nail clippers can be used to cut and shape the bill.

RODENT AND PREDATOR CONTROL

Norway rats and house mice are universal pests. They are best controlled by exclusion rather than removal, but they seem to be able to invade even the best and tightest of brooder houses and feed storage rooms in time.

Control of rats and mice by poison baits can be difficult because of the competition offered by an abundance of attractive feeds. In such cases, traps must be used, and this can be slow, never-ending work. Because of their great differences in living and eating habits, rats and mice are controlled by different techniques and even different poisons. A common error is to consider rats and mice as one problem and try to solve it with one control effort. This usually fails.

There are many poisons that, if properly used, can control rat and mice populations. Contact your local agricultural commissioner, Cooperative Extension farm advisor, the State Department of Fish and Game, or the State Department of Food and Agriculture to find out which poisons and poisoning techniques are recommended.

Trapping rats or mice is more an art of *where* than *how*. There are many good baits; almost any food that can be placed on the trigger is effective. Runway setting without bait is sometimes more effective. For both rat and mouse traps, an enlarged bait pan made from cardboard or light screen wire greatly improves results. It is important to set traps across the paths used by rats and mice—next to walls and between obstacles. Boxes or sacks may be used to form obstacles to force the rodent to pass over the trigger. Two or more traps set close together work well where there are many rats and mice or where there are trap-shy individuals. Use plenty of traps if you are going to trap at all. If travel is overhead, rat or mouse traps can be fastened to pipes, walls, or rafters. It is not necessary to clean or boil the traps or handle them with gloves; rats and mice are accustomed to human odors.

In dealing with predators, exclusion is perhaps even more important than in protection against rodents, because even one visit by a fox, mink, raccoon, bobcat, or skunk can be very costly in birds killed. Enclosed flight pens, if properly constructed, should do the job. However, the mesh ordinarily will not exclude weasels or snakes and certainly not rats and mice.

Damage to birds can result from fright if a predator outside the wire panics them, even if no entrance is made for direct killing. Therefore, some reduction of predators in the surrounding area may be necessary.

Skunks seem to be everywhere and are an important nuisance. In attacking bird flocks, skunks usually kill only one victim, and the predator can usually be identified by its clumsy mauling of the bird.

Opossums also maul their victims and also do a messy job of smashing eggs in pens if they get at them.

Weasels are very neat killers, usually biting the bird through the skull, the back of the neck, or under the wing. They don't stop with one, though; they may kill many birds in one night and place them in a neat pile.

Rats, too, are ruthless killers and, like the weasel, often pile their victims in a corner. They usually kill by slitting the bird's throat and are very slick at not disturbing the entire flock. Rats usually eat more from the carcass than do weasels, often pulling the bird partly into their burrows. Young birds and eggs will disappear completely.

Foxes don't usually kill a great number of birds at one time, and they carry off their victims.

Raccoons eat the heads off as many birds as possible, and they are persistent. Raccoons are clever, very strong, and excellent hunters.

Feral (wild) dogs and cats are a menace to any ground-dwelling wild birds. The cats are more likely to be a problem if there is sufficient heavy cover in which they can hide.

For all these predators, if control is deemed necessary, the selective method is shooting. Trapping with steel traps is effective if it can be done without endangering bird dogs or other nontarget animals, and if the operator has the right trap and knows how to use them. In many cases, a live trap is easier for an inexperienced trapper to use, and it is safer. Animals accidentally caught can be released unharmed.

PROCESSING GAME BIRDS

The procedures used to process fowl can be modified and used for most game birds. The size of equipment and degree of mechanization will depend upon the number of birds to be processed. Following is a procedure for processing game birds:

Slaughter

Hang the bird by its feet on the killing rack, sever the jugular vein behind the lower jaw, and allow the blood to drain. This method removes from 34 to 50 percent of the total blood of the body.

Picking

To remove the feathers, immerse the bird for 60 to 90 seconds in water heated to sub-scalding about 140 °F (60 °C). Test ease of feather removal by pulling a few tail or wing feathers. Remove feathers by hand or machine immediately after sub-scalding. A tub-type of picking machine equipped with rubber fingers on the side and bottom of the drum is preferred over the reel type of picker that requires the operator to hold each bird when removing the feathers. After the feathers are removed, scrub the carcass thoroughly to remove soiled areas and also to reduce the number of surface microorganisms.

Evisceration

Remove feet at the hock joint. Remove the oil gland on the tail: start 1 inch (2.5 cm) forward of the gland, then cut to the end of the tail. Cut the head off. Split the neck skin, starting from the shoulders and going to the end of the neck, and pull skin from the neck. Remove the trachea (windpipe) and esophagus (gullet) with the crop, and cut off the neck. Cut around the vent and gently pull until a few inches of the intestines are out. About half-way between the tip of the breast and vent make a crosswise cut about 3 inches (7.6 cm) long. Pull the vent and intestine through the cut and remove the viscera. Remove the heart, liver, and gizzard (giblets) and place them in a clean container for further processing. Remove all other organs, especially the lungs, making sure the body cavity is clean.

Packaging

Wash the carcass and giblets thoroughly. Chill in ice water kept at 40 °F (4 °C) for several hours. Remove from the water and drain. Place giblets in a small plastic bag, or wrap them in wax paper and place them inside the carcass. Tuck the legs of the carcass under the strip of skin left by the crosswise cut below the breast. Place the carcass in a plastic bag, draw out as much air as possible, and tie the bag with a wire tie. Air can be forced out of the plastic bag with a vacuum pump or by submerging the bag in water until it covers the carcass without entering the bag.

The dressed bird can be placed in containers and covered with crushed ice or dry-packed with CO₂ snow (dry ice) for shipment to market. (*Caution: Do not handle dry ice with your bare hands; it freezes the skin quickly.*)

Meat Quality

The quality of game bird meat may mean different things to different people. The present-day consumer judges quality on the basis of tenderness, moisture, and flavor. The old method of developing a “gamey” taste in game birds was to allow the bird to hang with feathers and viscera intact for several days. Federal and state regulations no longer permit birds to be “aged” in this manner, if the operation comes under the conditions where inspection is required.

Two factors affecting the quality of game bird meat are scalding and aging temperatures. The freshly cleaned carcass should be placed for several hours in slush ice (for chilling) and refrigerated. Aging time for adequate tenderization of the meat should be about 18 to 24 hours. Thereafter, the meat can be cooked or frozen.

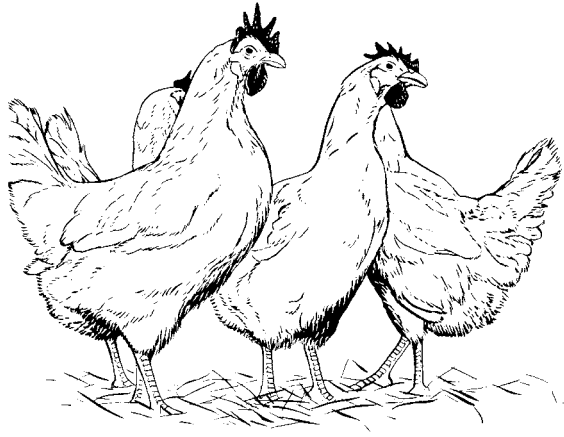
Spoilage

The processor must produce a wholesome product through proper handling and storage. Spoilage of game bird meat is due mainly to the development of microorganisms. Only a few species of psychrophilic (cold-loving) organisms cause spoilage in the meat. Freshly killed poultry contains approximately 1 to 10,000 microorganisms per square centimeter (1 square inch = 6.45 square cm). Spoilage in poultry usually occurs when the number of bacteria reaches 1 to 10 million per square centimeter. The first sign of spoilage is off-odor. Certain organisms also cause flavor changes as their numbers exceed the safe level. To help sanitize processing plants, some processors use chlorinated water to clean equipment and chill the birds.

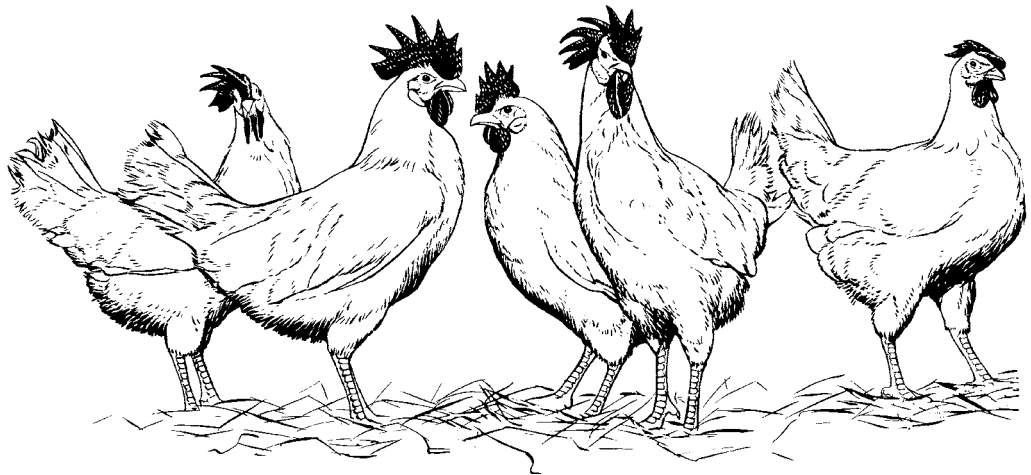
Laws

Laws regulating the processing and sale of game bird meats differ among states. Therefore, you should check with your State Department of Agriculture (food inspection) and local agencies for requirements on the processing of game bird meats.

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Eggcyclopedia



Eggs from A to Z

Exquisitely simple, yet enormously complex, the egg is one of nature’s marvels. Within this section are facts and figures, definitions and diagrams, graphs and even a few giggles—all related to various aspects of the egg. From air cell to yolk with such diverse topics as games and mythology, cooking tips and nutrient content tucked in between, the information is arranged alphabetically by subject for ease of reference. We hope it adds to your understanding and enjoyment of the incredible edible egg.

Nutrient Density of the Egg	
Percentage of Reference Daily Intake (RDI)* Provided by One Large Egg	
Vitamin A	6%
Thiamin	2%
Riboflavin.....	15%
Calcium.....	3%
Iron	4%
Vitamin D	6%
Vitamin E	3%
Vitamin B ₆	4%
Folic Acid	6%
Vitamin B ₁₂	8%
Sodium	3%
Potassium.....	2%
Phosphorus	9%
Magnesium	1%
Zinc.....	4%
Biotin.....	3%
Pantothenic Acid.....	6%

**Based on a 2,000-calorie diet. You may need more or less depending on your calorie needs.*

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Aioli

Garlic mayonnaise popular in the Provence region of southern France. - *See Mayonnaise*

Air Cell

The air-filled pocket between the white and shell at the large end of the egg.

When an egg is newly laid, it is about 105°F (41°C) and has either no air cell or a very small one. As the egg cools, the liquid contents contract more than the shell and the inner shell membrane separates from the outer shell membrane to form the air cell. As the egg ages, moisture and carbon dioxide leave through the pores of the shell, air enters to replace them and the air cell becomes larger. The flattened end of a peeled, hard-boiled egg shows you where the air cell once was.

The formation of the air cell and the separation of the shell membranes are the reasons that a slightly older egg is easier to peel after hard-boiling. Storing eggs upright in their cartons in the refrigerator helps to keep their air cells in place and maintain egg quality. Although the air cell usually forms in the large end of the egg, it occasionally moves freely toward the uppermost point of the egg as the egg is rotated. It is then called a free or floating air cell. If the main air cell ruptures, resulting in one or more small separate air bubbles floating beneath the main air cell, it is known as a bubbly air cell.

Candlers use the size of the air cell as one basis for determining grade.

Albumen

Also known as egg white. Depending on the size of the egg, albumen accounts for most of an egg's liquid weight, about 66%. The white contains more than half the egg's total protein, a majority of the egg's niacin, riboflavin, magnesium, potassium, sodium, and none of the fat. The white of a large egg contains about 17 calories.

Albumen color is opalescent and doesn't appear white until an egg is beaten or cooked. The cloudy appearance comes from carbon dioxide. As eggs age, carbon dioxide escapes, so the albumen of older eggs is more transparent than that of fresher eggs.

The albumen consists of four alternating layers of thick and thin consistencies. From the yolk outward, they are designated as the inner thick or chalaziferous white, the inner thin white, the outer thick white and the outer thin white. As an egg ages, the egg white tends to thin out because its protein changes in character. That's why fresh eggs sit up tall and firm in the pan while older ones tend to spread out.

When you beat egg white vigorously, it foams and increases in volume six to eight times. Egg foams are essential for making meringues, puffy omelets, soufflés, angel food and sponge cakes.

- *See Breakout; Chalazae; Color, White; Composition; Cooking Functions; Cooking Terms; Foam; Formation; Grading; Nutrient.*

American Egg Board

American Egg Board (AEB) is the promotion (advertising, marketing communications), education and research organization for the U.S. egg industry. The Board is composed of 18 members and 18 alternates. All members are egg producers who have been appointed by the Secretary of Agriculture to administer the program on behalf of all egg producers in the 48 contiguous states.

The Board was authorized by the Egg Research and Consumer Information Act passed by the 93rd Congress. The purpose of the law is "to enable egg producers to establish, finance and carry out a coordinated program of research, producer and consumer education and promotion to improve, maintain and develop markets for eggs, and egg products." The activities of the AEB are conducted under the oversight of the U.S. Department of Agriculture (USDA).

The staff of the AEB implements the programs and policies of the Board. Major programs consist of a national advertising and public relations campaign, as well as egg product, foodservice and retail marketing outreach and nutrition education activities, which are conducted through the AEB-funded Egg Nutrition Center.

Angel Food Cake

A cake, tall and light in texture, leavened only by beaten egg whites. Visit www.IncredibleEgg.org for an Angel Food Cake recipe.

Angel Pie

- *See Hard or Swiss Meringue*

Antibiotic-Free Eggs

Antibiotics are not used on a continuous basis in the egg industry. If hens become ill and antibiotics are needed, they're used on a therapeutic level under the supervision of a veterinarian. If hens are given an antibiotic at this level, their egg production is likely severely depressed. Any eggs produced would be diverted from human consumption according to FDA regulations.

Avian Influenza

Avian influenza (AI), also referred to as bird flu, is a virus that infects all types of avian species, including wild birds and domestic poultry. AI is an animal health issue that causes mild to severe symptoms in birds and, in its most extreme form, can be fatal to infected birds. Pathogenicity refers to an organism's ability to cause disease. There are two types of AI associated with domestic poultry, high pathogenicity (HPAI) and low pathogenicity (LPAI). LPAI is common in many areas of the world, may cause mild symptoms in birds and poultry, and is of no risk to human health. HPAI is more serious and causes severe illness in birds and poultry. In egg-laying hens, symptoms include respiratory problems, decreased food intake and slowed or stopped egg production.

In addition to pathogenicity (HP and LP), AI is also classified by the proteins on the surface of the virus. These proteins are hemagglutinin (H proteins) and neuraminidase (N proteins). There are 16 H proteins and 9 N proteins, so 144 different virus combinations are possible. Only two H proteins, H5 and H7, have been found to cause HPAI. All other H proteins are only found in LPAI and cause mild bird illness. The virus strain that is most talked about worldwide is H5N1. This strain is commonly found in Asia and has caused illness in millions of birds and in hundreds of people who have been in very close contact with the secretions or excretion of sick birds. The spread of AI viruses from one person to another is extremely rare.

The U.S. egg industry, local animal health officials, and many federal government agencies, including U.S. Department A – B 5 of Agriculture (USDA) have had years of experience in dealing with and preventing AI in commercial poultry flocks as well as protecting the health of consumers. USDA and the egg industry are well equipped to identify AI outbreaks quickly and to eradicate them immediately. There are many levels of protection built into commercial egg production. Most importantly, veterinarians monitor flock health daily and quickly identify any problems. The combination of daily monitoring with a nationwide, routine AI testing program is very effective at detecting illness. During regular testing of domestic flocks, it's not unusual to occasionally find LPAI. Outbreaks of HPAI, however, are rare. As of March 2012, there have been only three outbreaks of HPAI in the U.S. in the last 100 years. All three outbreaks were quickly eradicated and no human illnesses occurred.

If an HPAI outbreak were to occur, USDA and the egg industry have plans in place to quarantine and monitor the affected flock and surrounding area, eradicate the disease, as well as disinfect the premises and test to make sure the farm/s are free from AI virus. Under current regulations, eggs from an HPAI-positive flock will be destroyed immediately.

Another level of protection is that proper cooking destroys all AI virus particles. The USDA, the Food and Drug Administration and the World Health Organization all agree that thoroughly cooked eggs are safe to eat. Cook basic egg recipes until whites are firm and yolks thicken. Cook or bake any dishes containing eggs until they reach an internal temperature of 160°F (71°C).

– See *Cooking Methods, Doneness Guidelines, Egg Safety, Partnership for Food Safety Education, Raw Eggs*

Avidin

A protein found in small amounts (about 0.05%, five one-hundredths of 1%) in egg white. Avidin is inactivated by heat.

– See *Biotin*

Bain Marie

– See *Water Bath*

Baked Eggs

– See *Cooking Methods, Baked*

Beak Trimming

The old phrase “pecking order” comes from the fact that chickens do peck at one another, sometimes inflicting considerable injury and even death. To prevent this, the majority of commercial egg farms trim beaks when chicks are 10 days old or younger, when there is little stress, a practice supported by the scientific community. The process is similar to clipping a dog’s nails or trimming a horse’s hooves. Of course, chicks and hens with trimmed beaks can still eat and drink. Research has shown that mortality in flocks that are not beak-trimmed is considerably higher than in flocks that are beak-trimmed.

Bearnaise

– See *Hollandaise Sauce*

Beverages

You can make many beverages with eggs. When recipes call for raw eggs, to eliminate risk and ensure food safety, eggs need to be heated to 160°F (71°C) or use pasteurized shell eggs or egg products. Eggnog, for example, is a well-known beverage made from eggs and milk. Visit www.IncredibleEgg.org for an eggnog recipe.

– See *Doneness Guidelines, Eggnog, Egg Safety, Raw Eggs*

Biological Value

A measurement of protein quality expressing the rate of efficiency with which protein is used for growth.

The egg is a complete protein food because egg protein has all nine of the essential amino acids (as well as all nine of the non-essential amino acids). Scientists often use egg protein as the standard against which they judge all other proteins. Based on the essential amino acids it provides, egg protein is second only to mother’s milk for human nutrition. A large egg contains 6.29 grams of high-quality protein, about 12.6% of the Daily Reference Value (DRV) for protein.

– See *Nutrient, Protein*

Biotin

One of the B vitamins which plays an important role in cell metabolism and the utilization of fats, proteins and carbohydrates. Biotin is present in many foods, including egg yolk, and is synthesized by the body.

Avidin, one of the egg proteins, can combine with biotin and make biotin unavailable. However, a human would have to eat 24 raw egg whites a day for biotin to be inhibited by avidin. Heat inactivates the avidin, so biotin is not inhibited in cooked eggs. – See *Avidin*

Biological Values of Protein

On a scale, with 100 representing top efficiency, these are the biological values of proteins in several foods.

Whole egg	93.7
Milk	84.5
Fish	76.0
Beef	74.3
Soybeans	72.8
Rice, polished	64.0
Wheat, whole	64.0
Corn	60.0
Beans, dry	58.0

Source: Food and Agriculture Organization of the United Nations. The Amino Acid Content of Foods and Biological Data on Proteins, Nutritional Study #24. Rome (1970).

Bird Flu

– See *Avian Influenza B 7*

Blood Spots

Occasionally found on an egg yolk. These tiny spots do not indicate a fertilized egg. Instead, they are caused by the rupture of a blood vessel on the yolk surface during formation of the egg or by a similar accident in the wall of the oviduct.

Mass candling methods reveal most eggs with blood spots and those eggs are removed. However, even with mass scanners, it’s impossible to catch them all.

Both chemically and nutritionally, eggs with blood spots are safe to eat. You can remove the spot with the tip of a knife, if you wish.

– See *Formation, Grading*

Bloom

Also known as the cuticle, bloom is the natural coating or covering on the eggshell that seals the eggshell pores. The bloom helps to prevent bacteria from getting inside the shell and reduces moisture loss from the egg. In nature, the bloom dries and flakes off. Before they are sent to market, eggs are washed and sanitized, removing the bloom. About 10% of egg packers give eggs a light coating of edible mineral oil to restore the bloom.

– See *Cuticle, Oiling, Production*

“Blown Out” Eggshells

Shells from which the edible part of the egg has been emptied. With nothing inside to spoil, you can decorate empty eggshells and keep them indefinitely.

– See *Empty Eggshells*

Boiled Frosting

– See *Italian Meringue*

Bread Pudding

A simple, sweetened custard that is poured over pieces of bread, fruit, nuts or other flavorings and then baked. This classic dessert can be served hot or cold, sometimes with heavy cream or a dessert sauce. A savory version is called a strata.

Breakers

Processors who convert shell eggs into egg products. Breaking plants are under strict U.S. Department of Agriculture inspection by USDA’s Food Safety and Inspection Service. Breaking plants use a fascinating array of modern equipment to break eggs and separate the shell, white and yolk.

– See *Egg Products*

Breakout

A quality-control measure to supplement the grading process. The following criteria have been set by the U.S. Department of Agriculture (USDA) to judge egg quality. Sample eggs are selected at random and broken out onto a level surface. The height of the thick albumen (white) is measured with a tripod micrometer and this measurement is correlated with the weight of the egg to give a Haugh unit measurement. A high Haugh value means high egg quality. At the same time, the condition of the yolk is observed. The foodservice industry also uses a breakout test to evaluate the quality of eggs purchased. Simple observations of the condition of albumen (white) and yolk are considered adequate; generally the Haugh unit system is not used.

– See *Grading, Haugh Unit*

Grade AA: Egg content covers a small area. White is firm, has much thick white surrounding the yolk and a small amount of thin white. The yolk is round and upstanding.

Grade A: Egg content covers a moderate area. White is reasonably firm and has a considerable amount of thick white and a medium amount of thin white. The yolk is round and upstanding.

Grade B: Egg content covers a very wide area. White is weak and watery, has no thick white and the large amount of thin white is thinly spread. The yolk is enlarged and flattened.

Brown Eggs

– See *Color Shell*

Buying

Look for shells that are clean and whole. Cracked eggs are always removed from production, but some may be broken in handling. Don’t use an egg if it’s cracked or leaking.

Proper handling and refrigeration are important factors in maintaining egg quality. Eggs lose quality very rapidly at room temperature, so buy eggs only from refrigerated cases, get them home quickly and refrigerate

immediately. At temperatures of 35° to 45°F (2° to 7°C), you can store eggs with insignificant quality loss for three to five weeks after you bring them home.

Eggs are marketed according to grade and size standards established by the U.S. Department of Agriculture (USDA) or by state departments of agriculture. The USDA shield on the egg carton means that the eggs have been graded by U.S. or state department of agriculture representatives for consistency with USDA's standards for the voluntary grading of shell eggs.

Some egg packers may follow state standards, which must meet or exceed USDA standards. Some states have state seal programs which indicate that the eggs are produced within that state and are subject to continuing state quality checks. All eggs sold at the retail level must meet the standards for Grade B or better.

Size and grade are two entirely different factors and bear no relationship to one another. Grade is determined by the interior and exterior quality of the egg at the time the egg is packed. Size is determined by the average weight per dozen.

Grades (Buying)

Egg grades are labeled AA, A and B. There is no difference in nutritive value between the different grades. All eggs sold at the retail level must meet the standards for Grade B or better. Most eggs sold in supermarkets today are Grade AA or A. Although Grade B eggs are just as wholesome to eat, they rate lower in appearance when broken out. Few Grade B eggs find their way to the retail supermarket. Most go to institutional egg users such as bakeries or foodservice operations.

– See *Breakout, Grading*

Sizes (Buying)

Eggs are classified as jumbo, extra large, large, medium, small and peewee. The most common sizes available are medium, large and extra large, because hens most often lay eggs of these sizes. Sizes are classified according to minimum net weight expressed in ounces per dozen.

Which Size to Buy (Buying)

You can use any size egg for most basic egg recipes, including scrambled or fried eggs. However, most recipes for baked goods are formulas in which it's important to maintain the proper proportion of liquid to dry ingredients and to have enough whole egg, white or yolk to perform the needed functions. Most baking recipes are based on large-sized eggs. (To substitute one size egg for another in recipes, see Size Equivalents.) Most of the eggs sold in supermarkets are large-sized, but there are occasionally specials on other sizes. Use the following chart to find which size is the best buy. To compare the price of large eggs to the price of medium eggs, for example, run your fingers down the columns to the figures closest to the prices per dozen for large and medium eggs. Then, go across to the price per pound for each size. The one selling for the lower price per pound is the better buy. Always compare the same grade of eggs for an accurate price comparison. – See *Grading, Size Equivalents*

Egg Weight	
Egg Size	Oz. Per Dozen
Jumbo	30
Extra Large	27
Large	24
Medium	21
Small	18
Peewee	15
Source: U. S. Department of Agriculture (USDA) http://www.fsis.usda.gov/Factsheets/Focus_On_Shell_Eggs/index.asp#17	

Inexpensive Egg Protein (Buying)

Protein is an essential part of a nutritious diet but, for many people, foods that supply protein are some of the most expensive items on the grocery list.

Fortunately, the protein supplied by eggs is both high in quality and low in cost. It's easy to compare the price of eggs to the price of other protein foods. A dozen large eggs weigh 1 1/2 pounds, so the price per pound of large eggs is two-thirds of the price per dozen. For example, if large eggs cost \$1.45 per dozen, they cost 97¢ per pound. At \$1.75 per dozen, large eggs are only \$1.17 per pound. Another helpful formula is that one egg equals one ounce of lean meat, poultry or fish. This means that you can use two eggs as your main dish at a meal or you can use eggs to "stretch" more expensive protein foods. For instance, you might use one chopped hardboiled egg per serving along with half the usual amount per serving of expensive seafood in a dish.

– See *Meat Replacement, Protein*

Price Comparison Which size is the best buy?					
Small (18 oz)	Medium (21 oz)	Large (24 oz)	Extra-Large (27 oz)	Jumbo (30 oz)	PRICE/POUND (16 oz)
.68	.79	.90	1.01	1.13	.60
.75	.88	1.00	1.13	1.25	.665
.83	.96	1.10	1.24	1.38	.73
.90	1.05	1.20	1.35	1.50	.80
.98	1.14	1.30	1.46	1.63	.865
1.05	1.23	1.40	1.58	1.75	.93
1.13	1.31	1.50	1.68	1.88	1.00
1.20	1.40	1.60	1.80	2.00	1.065
1.28	1.49	1.70	1.91	2.13	1.13
1.35	1.58	1.80	2.03	2.25	1.20
1.43	1.66	1.90	2.14	2.38	1.265
1.50	1.75	2.00	2.25	2.50	1.335
1.58	1.84	2.10	2.36	2.63	1.40
1.65	1.93	2.20	2.48	2.75	1.465
1.73	2.01	2.30	2.59	2.88	1.53
1.80	2.10	2.40	2.70	3.00	1.60
1.88	2.19	2.50	2.81	3.13	1.665
1.95	2.28	2.60	2.93	3.25	1.73
2.03	2.36	2.70	3.04	3.38	1.80
2.10	2.45	2.80	3.15	3.50	1.865
2.18	2.54	2.90	3.26	3.63	1.93
2.25	2.63	3.00	3.38	3.75	2.00
2.33	2.71	3.10	3.49	3.88	2.065
2.40	2.80	3.20	3.60	4.00	2.13
2.48	2.89	3.30	3.71	4.13	2.20
2.55	2.98	3.40	3.83	4.25	2.265
2.63	3.06	3.50	3.94	4.38	2.33
2.70	3.15	3.60	4.05	4.50	2.40
2.78	3.24	3.70	4.16	4.63	2.465
2.85	3.33	3.80	4.28	4.75	2.53

Source: American Egg Board

Calcium

The major role of the mineral calcium is in building and maintaining bones and teeth. Calcium is also essential for many other body functions related to the blood, nerves and muscles. One large egg provides 28 milligrams (mg) of calcium, 2.6% of the Daily Reference Value (DRV) for calcium, most of which is in the yolk. An eggshell is composed largely of calcium carbonate (about 94%) along with small percentages of magnesium carbonate and calcium phosphate and, in total, contains about 2 grams of calcium.

– See Daily Value, Daily Reference Values (DRVs), Nutrient, Shell

Calories

The calorie count for eggs varies with size.
– See *Nutrient, Reference Daily Intakes (RDIs)*

Candling

The step in grading during which the egg grader looks inside the egg (without breaking it) to judge quality. Long ago, this quality check was done by holding a candle behind an egg. Some hand-candling, using electric equipment, is still used for spotchecking or for training egg graders, but today most eggs pass on rollers over high-intensity lights, which make the interior of the egg visible. The eggs are rotated so all parts are visible. The candler checks the size of the air cell and the distinctness of the yolk outline. Imperfections such as blood spots show up in candling. Very large packing plants may also use electronic blood and/or check detectors to sort and remove eggs exhibiting these defects.

– See *Air Cell, Blood Spots, Grading*

Egg Calories	
Egg Sizes	Calories Per Egg
Small	54
Medium	63
Large	72
Extra large	80
Jumbo	90

Source: U.S. Department of Agriculture, Agricultural Research Service. 2004. USDA National Nutrient Database for Standard Reference, Release 17.
Nutrient Data Laboratory Home Page,
<http://www.ars.usda.gov/nutrientdata>

Carotenoids

Antioxidants

– See *Xanthophylls, Lutein and Zeaxanthin*

Carton Dates

Egg cartons from plants producing USDA-graded eggs must display a Julian date – the date the eggs were packed. Although not required, egg cartons may also carry an expiration (sell-by) date and/or a best-by (use-by) date. On USDA grade-shielded egg cartons, if an expiration date appears, it can be no more than 30 days after the pack date. It may be less through the choice of the packer or quantity purchaser, such as your local supermarket chain. On USDA grade-shielded egg cartons, if a best-by (use-by) date appears, it can be no more than 45 days after the pack date. Eggs that are not packed under USDA's grading program must be labeled and coded in accordance with egg laws in the state where they are packed and/or sold. Most states require the use of a Julian date.

– See *Julian Dates, Expiration Date*

Cephalin

A phospholipid found in nerve tissues, including the white matter of the brain and spinal cord. One large egg contains 0.23 gram of cephalin.

– See *Nutrient*

Chalazae (kuh-LAY-zah)

Ropey strands of egg white which anchor the yolk in place in the center of the thick white. Chalazae are neither imperfections nor beginning embryos. The more prominent the chalazae, the fresher the egg. Chalazae don't interfere with the cooking or beating of the white and you don't need to remove them, although some cooks like to strain them from stirred custard.

– See *Composition*

Chantilly Meringue

– See *Italian Meringue*

Chinese Eggs

– See *Preservation*

Cholesterol

A fat-like substance found in every living cell in your body. Cholesterol is made in necessary amounts by your body and is stored in your body. Cholesterol is especially concentrated in your liver, kidney, adrenal glands and brain. Cholesterol insulates nerve fibers and must be available for your body to produce vitamin D.

Cholesterol is also required for the structure of cell walls, is essential to the production of digestive juices and is the basic building block for many hormones. Cholesterol is essential for life.

While your body produces cholesterol, dietary sources also can contribute to blood cholesterol levels. Research shows that a diet high in saturated fat, trans-fatty acids and excess calories contributes to increased levels of cholesterol in your blood.

Dietary cholesterol, found in all foods from animals, does not automatically raise your blood cholesterol levels. Your body usually compensates for dietary cholesterol by synthesizing smaller amounts in the liver, by excreting more or by absorbing less.

Elevated blood cholesterol levels do increase the risk of heart disease. You should know your blood cholesterol levels and, if they are elevated, follow your doctor's advice. In a blood cholesterol-lowering diet, research shows that the most important change you can make is to limit saturated fats and trans-fatty acids. Including fats – such as monounsaturated and polyunsaturated fats and omega-3 fatty acids – also may help improve blood cholesterol levels. A wealth of research has shown that eggs do not have a significant impact on blood cholesterol levels, so it's not necessary to avoid egg yolks, as part of an overall healthful diet. You can use egg whites freely.

One large egg contains 186 milligrams (mg) of cholesterol. Regardless of the color of the eggs, the hen's housing system, or whether the eggs are fertilized, the cholesterol content is the same unless the feed was altered, in which case a claim will appear on the carton. Cooking does not affect the cholesterol content of eggs.
– *See Fat*

Choline

Choline is essential for the normal functioning of all cells in your body and assures the structural development and signaling functions of cell membranes. Choline is made by your body but needed in larger amounts during pregnancy and lactation. When consumed during pregnancy, choline may be a key factor in the development of infants' memory functions and, later in life, choline may improve memory capacity. Animal studies have shown that a mother's insufficient choline production and intake during pregnancy can cause either defective memory or lower memory capabilities that last throughout life. Research shows that choline supplementation during fetal development enhances memory function. Egg yolks are an important source of choline (126 mg per large egg yolk) and provide 28% of a pregnant woman's daily needs (450 mg).

Choux Pastry

– *See Cream Puff*

Cleaning

Washing eggs to remove any dirt or stains. In modern laying houses, eggs are gathered shortly after they're laid and moved to automated washing equipment. Strict federal regulations specify the procedures and cleaning compounds that may be used. Today most eggs are cleaned in mechanical egg washers employing sprayers, brushes, detergent-sanitizers, rinses and driers. Only clean eggs go to the market.

In washing, the bloom is removed. About 10% of egg packers apply an edible mineral oil to replace it.
– *See Bloom, Oiling, Production*

Coddled Egg

1. An egg cooked in a coddler.
– *See Cooking Equipment, Coddler*
2. A less frequently used term for eggs cooked-in-the-shell for a very brief time.

Cold Storage

The practice of holding eggs in refrigerated warehouses. Commercial cold storage of eggs began in the U.S. in 1890. Because egg production was seasonal then, spring and summer eggs could be held in cold storage for release during periods of relative scarcity in autumn and winter. This practice helped avoid drastic price fluctuations.

Modern breeding and flock management have virtually eliminated seasonal differences in egg production so that cold storage is neither necessary nor practical. Thanks to rapid handling methods and efficient transportation, most eggs reach the supermarket warehouse within a few days of being laid.

– *See Preservation, Storing*

Color

Egg shell and yolk color may vary. Color has no relationship to egg quality, flavor, nutritive value, cooking characteristics or shell thickness.

Shell (Color)

Shell color comes from pigments in the outer layer of the shell and, in eggs from various commercial breeds, may range from white to deep brown. The breed of hen determines the color of the shell. Among commercial breeds, hens with white feathers and ear lobes lay white-shelled eggs; hens with red feathers and ear lobes lay brown eggs.

White eggs are most in demand among American buyers. In some parts of the country, however, particularly in New England, brown shells are preferred. Commercial brown-egg layers are hens derived from the Rhode Island Red, New Hampshire and Plymouth Rock breeds. Since brown-egg layers are slightly larger birds and require more food, brown eggs are usually more expensive than white.

White (Albumen)

Egg albumen in raw eggs is opalescent and doesn't appear white until you beat or cook it.

Yolk

Yolk color depends on the hen's diet. If a hen consumes plenty of yellow-orange plant pigments called xanthophylls, the xanthophylls will be deposited in the egg yolk. Hens fed mashes containing yellow corn or alfalfa meal lay eggs with medium-yellow yolks, while those eating wheat or barley yield lighter-colored yolks. A colorless diet, such as white cornmeal, produces almost colorless yolks. Natural yellow-orange substances, such as marigold petals, may be added to light-colored feeds to enhance yolk color. Artificial color additives are not permitted. Gold or lemon-colored yolks are the most common. Yolk pigments are relatively stable and are not lost or changed in cooking. A **green** ring around hard-boiled egg yolks is the result of sulfur and iron compounds in the egg reacting at the surface of the yolk. The greenish color may occur when you cook eggs for too long or at too high a temperature or when there is a high amount of iron in the cooking water. Although the color may be unappealing, eggs with green rings are still wholesome and nutritious and have a normal flavor. The best ways to avoid greenish yolks are to use the proper cooking time and temperature and to rapidly cool the cooked eggs.

– See *Cooking Methods, Hard-Boiled*

Sometimes a large batch of scrambled eggs turns green. Although not pretty, the color change is harmless. Just as in hardboiled eggs, the green color is the result of heat causing a chemical reaction between the eggs' iron and sulfur. The green color occurs when you cook eggs at too high a temperature, hold them for too long, or both. To prevent the coloring, use stainless steel equipment and a low cooking temperature, cook the eggs in small batches and serve them as soon as possible after cooking. If it's necessary to hold scrambled eggs for a short time before serving, it helps to avoid direct heat. Place a pan of hot water between the pan of eggs and the heat source.

Occasionally several concentric green rings appear in hard-boiled egg yolks. A yolk develops within the hen in rings. As the rings are formed, iron in the hen's feed or water may cause the green coloring.

Complete Protein

- See *Protein*

Composition

Shell

- Outer covering of egg, composed largely of calcium carbonate
- May be white, brown or even blue-green depending on breed of chicken
- Color does not affect egg quality, flavor, cooking characteristics, nutritive value or shell thickness

Yolk

- Yellow portion of egg
- Color varies with feed of the hen, but doesn't indicate nutritive content
- Major source of egg vitamins, minerals and fat and about half of the protein
- Germinal Disc

Vitelline (Yolk) Membrane

- Clear seal which holds yolk

Chalazae

- Twisted, cord-like strands of egg white
- Anchor yolk in center of egg
- Prominent chalazae indicate freshness

Air Cell

- Pocket of air formed at large end of egg
- Caused by contraction of the contents during cooling after laying
- Increases in size as egg ages

Shell Membranes

- Two membranes - inner and outer shell membranes - surround the albumen
- Provide protective barrier against bacterial penetration
- Air cell forms between these two membranes

Thin Albumen (White)

- Nearest to the shell
- Spreads around thick white of high-quality egg

Thick Albumen (White)

- Major source of egg riboflavin and protein
- Stands higher and spreads less than thin white in higher-grade eggs
- Thins and becomes indistinguishable from thin white in lower-grade eggs

Cooking Equipment

It's easy to cook eggs with no special kitchen equipment. For example, you don't need to have a double boiler to cook egg sauces and custards. Simply use a heavy-gauge saucepan over low heat. However, there are some pieces of kitchen equipment designed especially for preparing eggs. Some of these items – such as an electric egg cooker – are limited to egg use only, while others – such as custard cups – come in handy for a variety of foods.

As a rule, on top of the range, cooking is more even in heavy-gauge pots and pans. Baking dishes and pans of the proper size are particularly important for items that rise, such as breads, cakes and soufflés.

Beaters

Cooks once had to rely on muscle power to whip eggs. They used an assortment of large and small, flat and balloon-shaped whisks, many of which are still available. Today, most cooks use an electric stand or hand mixer. Blenders and some food processors can whip up a whole egg, an egg yolk or a mixture but do not produce stiffly beaten egg whites.

Bowls

There has long been a great controversy about the merits, if any, of using a copper bowl to produce volume in beaten egg whites. The copper in the bowl reacts with the conalbumin of egg whites much like cream of tartar to stabilize egg-white foam. With the addition of cream of tartar, a stainless steel or glass bowl works just as well, is much less expensive and avoids the possibility of copper leaching into food.

Because they tend to absorb fat, plastic and wooden bowls aren't suitable for beating egg whites. Any film or residue of fat will keep the whites from forming a stable foam.

The size and shape of a bowl is important. When you use an electric stand mixer, use the bowl that comes with the mixer. A deep bowl with enough room for expansion is best for an electric hand mixer. For hand-whipping with a balloon whisk, use a bowl that's rounded at the bottom, at least 10 inches across the top and 5 to 6 inches deep.

Cooking Equipment Especially For Eggs

Coddler

A small cup made of porcelain, heatproof glass or pottery with a screw-on top. To use a coddler, break an egg or two into the cup, screw on the top and submerge the cup in simmering water until the egg is cooked. Eat the eggs directly from the coddler. You can also coddle eggs in a small jelly-size canning jar.

Cooker

An electric appliance which steamcooks eggs in the shell. Most egg cookers also have inserts or cups for steam-poached eggs and some have a flat insert for cooking fried or scrambled eggs and omelets.

Crepe Pan

A shallow, slope-sided skillet, 6 to 8 inches in diameter. Crepe pans range from inexpensive, lightweight pans to sophisticated electric models, some of which cook the crepes on what appears to be the outside of the pan. You can make crepes in almost any small shallow pan with sloping sides, such as a small omelet pan.

Custard Cups

Small, deep, individual bowlshaped dishes, with a capacity of 6 or 10 ounces, designed for oven use and perfect for baking eggs, individual custards or quiches.

Omelet Pan

A shallow, slope-sided nonstick skillet, usually 7 to 10 inches in diameter. A double omelet pan consists of 2 shallow rectangular or semicircular pans attached by hinges. Each pan has a handle.

Piercer

A sharp-pointed tool for gently pricking a very small hole in the large end of an eggshell before hard-boiling. Piercing may allow some air to escape and some water to seep into the egg during cooking, which may make peeling easier. However, piercing often produces hairline cracks in the shell, making the egg more vulnerable to bacteria. For this reason, piercing is not recommended. To make peeling hard-boiled eggs easier, use eggs that are 7 to 10 days old.

Poacher

A rack that holds cups, sized to fit one egg each, over simmering water, or a small colander-like form that holds an egg as it poaches in simmering water.

Quiche dish

A round, shallow, straight-sided ceramic dish, usually with scalloped edges, for oven use. Sometimes also called a flan or tart dish, a quiche dish is available in several sizes. You can also use a pie plate of the same size to bake a quiche.

Ring

A round band, with or without a handle, to hold a fried egg during cooking.

Separator

A small cup centered in a round frame made of plastic, metal or ceramic. The cup catches the yolk while slots around the frame let the white slip through to a container beneath the separator. You can also use a kitchen funnel to separate eggs.

Slicer

A device which cuts a hard-boiled egg into neat slices with one swift stroke. An egg slicer has an indented tray in which the egg rests and a cutting mechanism of parallel wires. To chop an egg, carefully rotate the sliced egg 90 degrees in the tray and cut through again. You can also chop eggs using a pastry blender in a bowl or with a sharp knife on a cutting board.

Soufflé dish

A deep, straight-sided dish designed for oven use. Soufflé dishes are available in various sizes and can serve as casserole dishes, too. You can also bake a soufflé in a straight-sided casserole or baking dish or an uncoated saucepan of the same size.

Wedger

A device which cuts a hard-boiled egg into 6 equal wedge-shaped parts. The wedger holds the egg upright as you pull wires over it to cut the wedges. When you draw down the wires only partway, you can open the egg to hold a stuffing or to resemble a flower.

Cooking Functions

Although eggs are widely known as breakfast entrees, they also serve in many other ways. In fact, the cooking properties of eggs are so varied that eggs have been called “the cement that holds together the castle of cuisine”.

Eggs **bind** ingredients in dishes such as meatloaves or crab cakes, **leaven** such baked high-rises as soufflés and sponge cakes and **thicken** custards and sauces.

Eggs **emulsify** mayonnaise, salad dressings and Hollandaise sauce and are frequently used to **coat or glaze** breads and cookies.

Eggs **clarify** soups and coffee and **retard crystallization** in boiled candies and frostings.

Eggs **add color, flavor, moisture and nutrients** to baked goods such as cakes. As a finishing touch, hard-boiled eggs often serve as a garnish. For more in-depth information visit www.IncredibleEgg.org

Cooking Methods

The basic principle of egg cooking is to use a medium to low temperature and time carefully. When you cook eggs at too high a temperature or for too long at a low temperature, the whites shrink and become tough and rubbery and the yolks become tough and their surface may turn gray-green.

To kill bacteria and other microorganisms, the recommended guidance is to cook eggs until the whites are firm and the yolks thickened. Cook egg dishes to an internal temperature of 160°F (71°C). Pasteurized shell eggs are available on the market for those who prefer eggs not cooked to this level of doneness. There are five basic methods for cooking eggs.

Baked

Eggs baked in a dish in the oven, also known as shirred. Break and slip 2 eggs into a greased 10-ounce custard cup, shallow baking dish or ramekin. Spoon 1 tablespoon milk or half and half over the eggs. Bake in a preheated 325°F (163°C) oven until the whites are completely set and the yolks begin to thicken but are not hard, about 10 to 12 minutes, depending on the number of servings you’re baking.

Hard-boiled/Hard-cooked

Place eggs in a saucepan large enough to hold them in a single layer. Add enough cold water to come at least 1 inch above the eggs. Heat over high heat to boiling. Turn off heat. If necessary, remove the pan from the burner to prevent further boiling. Cover pan. Let the eggs stand in the hot water about 12 minutes for large eggs (about 9 minutes for medium, about 15 for extra-large). Immediately run cold water over the eggs or place them in ice water until they’re completely cooled. Never microwave eggs in the shell and unfortunately, it’s almost impossible to hard-boil eggs at altitudes above 10,000 feet.

– See *Peeling*

Fried

For Sunny-Side-Up Eggs: Heat a small amount of butter in nonstick skillet over medium-high heat until hot. Break eggs and slip into pan, one at a time. Immediately reduce heat to low. Cover pan and cook slowly until whites are completely set and yolks begin to thicken but are not hard, 5 to 6 minutes. Sprinkle with salt and pepper.

For Over-Easy or Over-Hard Eggs: Cook as for Sunny-Side-Up, but do not cover pan. When whites are completely set and yolks begin to thicken but are not hard, 5 to 6 minutes. Slide turner under each egg and carefully flip it over in pan. Cook second side to desired doneness, 30 seconds to 1 minute.

For Basted Eggs: Cook as for Sunny-Side-Up, but use 2 tablespoons butter and do not cover pan. Cook until edges turn white, about 1 minute. Begin basting eggs with butter from pan. Cover pan between basting and continue cooking until whites are completely set and yolks begin to thicken but are not hard, 4 to 5 minutes.

For Steam-Basted Eggs: cook as for Sunny-Side-Up, but use 1 teaspoon butter or a light coating of cooking spray. Cook until edges turn white, about 1 minute. Add 1 teaspoon water to pan. Cover pan tightly. Continue cooking until whites are completely set and yolks begin to thicken but are not hard, 4 to 5 minutes.

Poached

Heat 2 to 3 inches of water, milk, broth, tomato juice, wine or other liquid in a large saucepan or deep skillet to boiling. Adjust heat to keep liquid simmering gently. Break cold eggs, one at a time, into a custard cup or saucer. Holding the dish close to the liquid's surface, slip the eggs, one by one, into the water. Cook until the whites are completely set and the yolks begin to thicken but are not hard, about 3 to 5 minutes. Do not stir. With a slotted spoon, lift out the eggs. Drain the eggs in the slotted spoon or on paper towels. Trim any rough edges, if you like. Adding vinegar or salt to the water to enhance coagulation is not necessary and can flavor the eggs. Use very fresh eggs for poaching. They hold their shape better and form fewer wispy threads or "angel wings" in the water.

Scrambled

Beat together 2 eggs, 2 tablespoons milk or water, salt and pepper, if you like, until blended. Heat a small amount of butter or cooking spray in a 7 to 8 inch nonstick omelet pan or skillet over medium heat until hot. Pour in the egg mixture. As the eggs begin to set, gently pull the eggs across the pan with an inverted turner, forming large soft curds. Continue cooking – pulling, lifting and folding eggs until thickened and no visible liquid egg remains. Do not stir constantly.

Cooking Terms

The following terms or phrases regularly occur in egg recipes.

Cook until knife inserted near center comes out clean. Baked custard mixtures are done when a metal knife inserted off center comes out clean. The very center still may not be quite done, but the heat retained in the mixture will continue to cook it after you remove it from the oven. Cooking longer may result in a curdled and/or weeping custard. Cooking less time may result in a thickened but not set custard.

Cook until just coats a metal spoon. For stirred custard mixtures, the eggs are cooked to the proper doneness when a thin film adheres to a metal spoon dipped into the custard. The point of coating a metal spoon is 20° to 30°F below boiling. Stirred custards should not boil. The finished product should be soft and thickened but not set. Stirred custards will thicken slightly after refrigeration.

Slightly beaten. Beat eggs with a fork or whisk just until the yolks and whites are blended.

Well beaten. Beat eggs with a mixer, blender, beater or whisk until they are light, frothy and evenly colored.

Thick and lemon-colored. Beat yolks with an electric mixer at high speed until they become a pastel yellow and form ribbons when you lift the beater or drop the yolks from a spoon, about 3 to 5 minutes. Although yolks can't incorporate as much air as whites, this beating does create a foam and is important to airy concoctions such as sponge cakes.

Add a small amount of hot mixture to eggs/egg yolks. When you add eggs or egg yolks to a hot mixture all at once, they may begin to coagulate too rapidly and form lumps. So, stir a small amount of the hot mixture into the eggs to warm them and then stir the warmed eggs into the remaining hot mixture. This is called **tempering**.

Room temperature. Some recipes call for eggs to be at room temperature before you combine the eggs with a fat and sugar. Cold eggs could harden the fat in this type of recipe and the batter might become curdled. This could affect the texture of the finished product. To prevent the curdling, remove eggs from the refrigerator about 30 minutes before you use them or put them in a bowl of warm water for 10 to 15 minutes while you assemble other ingredients. For all other recipes, use eggs straight from the refrigerator.

The following cooking terms apply specifically to egg whites.

Separated. Fat inhibits the foaming of egg whites. Since egg yolks contain fat, recipes sometimes call for the yolks to be separated from the whites. Beating the whites separately allows them to reach their fullest possible volume. It's easiest to separate the yolks and whites when the eggs are cold, but whites reach their fullest volume if you allow them to stand at room temperature for about 30 minutes before beating.

Many inexpensive egg separators are available. To separate eggs, tap the midpoint of the egg sharply with a table knife. Hold the egg over the bowl in which you want the whites and gently pull apart the shell halves. Let the yolk nestle into the cuplike center of the separator and the white will drop through the slots into the bowl beneath. You can use the same process with a funnel.

Drop one egg white at a time into a cup or small bowl and then transfer it to the mixing bowl before separating another egg. This avoids the possibility of yolk from the last egg you separated getting into several whites. Drop the yolk into another mixing bowl if you need it in the recipe, otherwise into a storage container.

– See *Storing*

Add cream of tartar. Egg whites beat to greater volume than most other foods, including whipping cream, but the air beaten into them can be lost quite easily. To make the foam more stable, add a stabilizing agent such as cream of tartar to the whites. Lemon juice works much the same way.

– *See Cream of Tartar*

Add sugar, 1 to 2 tablespoons at a time. When you make meringues and some cakes, you add sugar to beaten egg whites. Sugar serves to increase the stability of the foam. However, sugar can also retard the foaming of the whites and you must add it slowly so you don't decrease the volume. Beat the whites until they just begin to get foamy, then slowly beat in the sugar.

– *See Meringue*

Stiff but not dry. Beat whites with a mixer, beater or whisk just until they no longer slip when the bowl is tilted. (A blender or food processor will not aerate them properly.) If you underbeat egg whites, the finished product may be heavier and less puffy than desired. If you overbeat egg whites, they may form clumps which are difficult to blend into other foods in the mixture and the finished product may lack volume.

Stiff peaks form. Stiff but not dry.

Soft peaks or piles softly. Whites that have been beaten until high in volume but have not reached the stiff peak stage. When you lift the beater, peaks will form and curl over slightly.

Gently folded. When you combine beaten egg whites with other heavier mixtures, handle carefully so you don't lose the air you've beaten into the whites. It's best to pour the beaten egg whites onto the heavier mixture. Then, using a spoon or rubber spatula, gradually combine the ingredients with a downward stroke into the bowl, followed by an across-up-andover- the-mixture motion. Come up through the center of the mixture about every three strokes and rotate the bowl as you are folding. Fold just until there are no streaks remaining in the mixture. Don't stir because this will force air out of the egg whites.

Copper Bowl

– *See Cooking Equipment, Bowls*

Cream of Tartar

An acid ingredient which stabilizes beaten egg whites. As a rule of thumb, use 1/8 teaspoon cream of tartar per egg white or 1 teaspoon per cup of egg whites. For meringues, use 1/8 teaspoon cream of tartar for each 2 egg whites.

– *See Cooking Terms, Add Cream of Tartar*

Cream Puff

A light, but rich, hollow pastry puff which you can fill with a sweet filling for dessert or with a savory one, such as egg or chicken salad, for a main dish. Called choux pastry (Pâte or choux) after the French word for cabbage, cream puffs come out of the oven looking like little cabbages. A high proportion of egg is necessary to form the cream puff structure. Egg yolk helps to emulsify the fat and egg whites are drying agents for crisp, dry puffs. Visit www.IncredibleEgg.org for a cream puff recipe.

Crème Anglaise

– *See Custard, Stirred*

Crème Caramel

– *See Custard, Baked*

Crepe

A light, thin, egg-rich pancake. The word is French, but the crepe is so versatile that it exists in many other languages, too. It's a Russian blini, a Jewish blintz, a Chinese egg roll, a Greek krep or a Hungarian palacsinta. Depending on the filling, a crepe can be an appetizer, main dish or dessert. Crepe batter should be the consistency of heavy cream. Letting the batter rest for an hour or so after mixing allows the flour to absorb moisture and gives the air bubbles time to dissipate so that the crepes you make don't have tiny holes. You can make crepes in advance. Stack, wrap and refrigerate them for a few days and reheat to serve. For longer storage, double wrap and freeze. Visit www.IncredibleEgg.org for a crepe recipe.

Curdling

Also known as syneresis or weeping. When you cook an egg mixture such as a custard sauce too rapidly or for too long, the protein becomes overcoagulated and separates from the liquid, leaving a mixture resembling fine curds and whey. If the curdling in a custard sauce hasn't progressed too far, you may be able to reverse it if you remove the mixture from the heat and stir or beat vigorously.

To prevent syneresis or curdling in a custard sauce, use a low temperature, stir (if appropriate for the recipe), cook just until the custard tests done, and cool quickly by setting the pan in a bowl of ice or cold water and stirring for a few minutes.

The term curdling is usually used in connection with a stirred mixture such as custard sauce, while weeping or syneresis are more often used with reference to pie meringues or baked custards.

– See *Meringue*, *Soft Meringue*

Custard

A cooked mixture of eggs and milk with sugar and flavoring sometimes added. There are two basic kinds of custard – stirred and baked.

Stirred custard is also known as soft custard, custard sauce or erroneously, boiled custard. This custard is cooked on top of the range to a creamy, but pourable, consistency. You can cook the mixture in a double boiler over hot water or in a heavy saucepan over low heat. Serve stirred custard as a pudding or over cake or fruit. Visit www.IncredibleEgg.org for a vanilla custard sauce recipe.

Baked custard is cooked in a water bath in the oven and has a firm, but delicate, gel-like consistency. Serve a sweetened baked custard as a dessert in itself or as a base for toppings and sauces. A quiche or timbale is an unsweetened baked custard.

The usual proportions for a sweet custard are one egg and two tablespoons of sugar for each cup of milk. This is the minimum ratio of eggs to milk which will produce properly thickened custard. You may, though, use as many as four eggs and increase the sugar to four tablespoons. Increasing the sugar will make the custard less firm and lengthen the cooking time. Increasing the egg will make the custard firmer and shorten the cooking time. You can also substitute two egg yolks for one whole egg. Two egg whites will also thicken the custard as much as one whole egg, but the characteristic custard color and flavor will be missing.

Visit www.IncredibleEgg.org for baked custard and quiche recipes.

Cuticle

– See *Bloom*

Daily Reference Values (DRVs)

There are two sets of reference values for reporting nutrients in nutrition labeling: 1) Daily Reference Values (DRVs) and 2) Reference Daily Intakes (RDIs). These values assist consumers in interpreting information about the amount of a nutrient that is present in a food and in comparing nutritional values of food products. DRVs are established for adults and children four or more years of age, as are RDIs, with the exception of protein. DRVs are provided for total fat, saturated fat, cholesterol, total carbohydrate, dietary fiber, sodium, potassium, and protein. RDIs are provided for vitamins and minerals and for protein for children less than four years of age and for pregnant and lactating women. In order to limit consumer confusion, however, the label includes a single term (i.e., Daily Value (DV)), to designate both the DRVs and RDIs. Specifically, the label includes the % DV, except that the % DV for protein is not required unless a protein claim is made for the product or if the product is to be used by infants or children under four years of age.

– See *Daily Values (DVs)*, *Reference Daily Intakes (RDIs)*, *Recommended Dietary Allowances (RDAs)*, *U.S. Recommended Daily Allowances (U.S. RDAs)*

Daily Values (DVs)

A term on food labels that represents the amount of protein, fat, cholesterol, carbohydrate (including dietary fiber and sugars), vitamins and minerals, expressed in percentage of a specific nutrient that a person should consume per day. To avoid consumer confusion, the term DV represents both Daily Reference Values (DRVs) and Reference Daily Intakes (RDIs). DVs serve as a yardstick for food comparisons and not as a strict dietary prescription.

– See *Daily Reference Values*, *Reference Daily Intakes (RDIs)*, *Recommended Dietary Allowances (RDAs)*, *U.S. Recommended Daily Allowances (U.S. RDAs)*

Daily Values (DV's)	
DV's based on a caloric intake of 2,000 calories, for adults and children four or more years of age.	
Food Component	DV
Total Fat	65 grams (g)
Saturated Fat	20 g
Cholesterol	300 milligrams (mg)
Sodium	2,400 mg
Potassium	3,500 mg
Total Carbohydrate	300 g
Dietary Fiber	25 g
Protein	50 g
Vitamin A	5,000
	International Units (IU)
Vitamin C	60 mg
Calcium	1,000 mg
Iron	18 mg
Vitamin D	400 IU
Vitamin E	30 IU
Vitamin K	80 micrograms mcg
Thiamin	1.5 mg
Riboflavin	1.7 mg
Niacin	20 mg
Vitamin B6	2 mg
Folate	400 mcg
Vitamin B12	6 mcg
Biotin	300 mcg
Pantothenic acid	10 mg
Phosphorus	1,000 mg
Iodine	150 mcg
Magnesium	400 mg
Zinc	15 mg
Selenium	70 mcg
Copper	2 mg
Manganese	2 mg
Chromium	120 mcg
Molybdenum	75 mcg
Chloride	3,400 mg

The nutrients in the table are listed in the order in which they are required to appear on a label in accordance with 21 CFR 101.9(c). This list includes only those nutrients for which a DRV has been established in 21 CFR 101.9(c)(9) or a RDI in 21 CFR 101.9(c)(8)(iv). Source: Dietary Reference Intakes: The Essential Guide to Nutrient Requirements, Jennifer J. Otten, Jennifer Pitzel Hellwig, Linda D. Meyers, Editors, The National Academies Press, 2006

Decorating Eggs

The egg shape has often inspired artists and the egg has been the palette for some of the most intriguing of folk arts in many cultures.

There is literally no end to the creative possibilities for individual expression on an eggshell. You can paint eggs or color them with crayons or felt-tipped pens, turn them into funny faces, top them with fantastic hats, trim them with feathers or sequins or simply dye them in an endless variety of hues. However you decide to do it, decorating eggs is fun for grown-ups as well as kids.

You can decorate either hard-boiled eggs or empty eggshells. The hardboiled variety is a bit sturdier for children to use, while empty shells are best if you're making an egg tree or want to keep the eggs on display for a considerable time.

Commercial egg dyes are sold especially at the Easter season and food coloring is available year round. Any time of year, you might prefer to craft your eggs by experimenting with colors from nature.

To make naturally-dyed eggs: Toss your choice of a handful – or two or three – of one of the materials below into a saucepan. (Use your own judgment about quantity. This is an art – not a science!) Add about a cup of water for each handful, so the water comes at least an inch above the dyestuff. Bring to boiling, reduce the heat and simmer from 15 minutes up to an hour, until the color is the shade you want. Keep in mind that

Naturally-Dyed Eggs

Pinkish Red

Fresh beets, cranberries, radishes
3 or frozen raspberries

Orange/Yellow

Yellow onion skins, ground turmeric,
orange or lemon peels, carrot tops,
celery seed or ground cumin

Pale Green

Spinach leaves

Green-gold

Yellow Delicious apple peels

Blue

Canned blueberries or red
cabbage leaves

Beige to brown

Strong brewed coffee, dill seeds,
chili powder

Gray

Purple or red grape juice or beet juice

Source: American Egg Board

the eggs will dye a lighter shade. Remove the pan from the heat.

Through cheesecloth or a fine sieve, strain the dye mixture into a small bowl that's deep enough to completely cover the eggs you want to dye. Add 2 to 3 teaspoons of white vinegar for each cup of dye liquid. With a spoon or wire egg holder from a dyeing kit, lower the eggs into the hot liquid. Let the eggs stand until they reach the desired color. For emptied eggshells, stir or rotate for even coloring. With a slotted spoon or wire egg holder, remove the eggs to a rack or drainer. Allow the eggs to dry thoroughly. Within two hours (or within one hour if the weather is warm), refrigerate hardboiled eggs that you intend to eat.

However you decide to color your hard-boiled eggs, follow these tips if you'd like to eat them later: Wash your hands thoroughly before handling the eggs at every step, including cooking, cooling, dyeing and hiding. If you won't be coloring your eggs right after cooking them, store them in their cartons in the refrigerator. Don't color cracked eggs.

When coloring the eggs, use water warmer than the eggs. Refrigerate the eggs in their cartons right after coloring and refrigerate them again after they've been hidden and found. Don't eat cracked eggs or eggs that have been out of refrigeration for more than two hours. If you plan to use hard-boiled eggs for an Easter egg hunt or as a centerpiece or other decoration and they will be out of refrigeration for many hours or several days, cook extra eggs to refrigerate for eating. Discard the eggs that have been left out for more than two hours. For more decorating ideas, visit www.IncredibleEgg.org

– See *Cooking Methods, Hard-Boiled; Empty Eggshells; Easter Eggs*

Deviled Eggs

Also known as stuffed eggs, hardboiled eggs, peeled, cut in half and stuffed with a seasoned, mashed yolk mixture. The yolks are removed from the whites, mixed with a moistener, such as mayonnaise, flavoring foods and/or seasonings and then piled back into the whites. The word “devil” originally referred to the combination of spices, including dry mustard, with which the eggs were highly seasoned. D

Doneness Guidelines

To prevent food-borne illness, U.S. Department of Agriculture (USDA) recommends cooking eggs until the whites are firm and yolks are thickened. Cook egg-containing dishes to an internal temperature for 160°F (71°C). For egg preparations not cooked to these guidelines, pasteurized shell eggs are available on the market. Eggs should be served promptly after cooking.

- Cook **scrambled eggs, omelets and frittatas** until the eggs are thickened and no visible liquid egg remains.
- To cook both sides of **fried eggs** and increase the temperature the eggs reach, cook slowly and baste the eggs, turn the eggs or cover the pan with a lid. Cook until the whites are completely set and the yolks begin to thicken but are not hard.
- For classic **poached eggs** cooked gently in simmering water, cook until the whites are completely set and the yolks begin to thicken but are not hard, about 3 to 5 minutes. For steamed eggs cooked in “poaching” inserts set above simmering water, cook until the whites are completely set and the yolks begin to thicken but are not hard, about 6 to 9 minutes. Avoid precooking and reheating poached eggs.
- Cook or bake **French toast, Monte Cristo sandwiches, crab or other fish cakes, quiches, baked custards and most casseroles** until a thermometer inserted at the center shows 160°F (71°C) or a knife inserted near the center comes out clean. You may find it difficult to tell if a knife shows uncooked egg or melted cheese in some casseroles and other combination dishes that are thick or heavy and contain cheese – lasagna, for example. To be sure these dishes are done, make sure that a thermometer at the center of the dish shows 160°F (71°C).
- Cook a **soft (stirred) custard – including cream pie, eggnog and ice cream bases** – until it's thick enough to coat a metal spoon with a thin film and a thermometer shows 160°F (71°C) or higher but no higher than 180°F (83°C). A custard sauce thickens at 160°F (71°C) and curdles at 180°F (83°C). An exception to the rule is when cream pie fillings and puddings that contain a starch, the addition of starch prevents curdling even when the mixture is brought to a boil. After cooking, cool the custard quickly by setting the pan in ice or cold water and stirring for a few minutes. Cover and refrigerate the cooled custard to chill thoroughly, at least 1 hour.
- Bake a 3-egg-white **soft (pie) meringue** spread on a hot, fully cooked pie filling in a preheated 350°F (177°C) oven until the meringue reaches 160°F (71°C), about 15 minutes. For meringues using more whites, bake at 325°F (163°C) or a lower temperature until a thermometer registers 160°F (71°C), about 25 to 30 minutes (or more). The more egg whites, the lower the temperature and longer the time you need to cook the meringue through without excessive browning. Refrigerate meringue-topped pies until serving. Return leftovers to the refrigerator.

• **Baked goods and hard-boiled eggs** will easily reach internal temperatures of more than 160°F (71°C) when they are done. Note, though, that while Salmonella are destroyed when hard-boiled eggs are properly prepared, hard-boiled eggs can spoil more quickly than raw eggs. After cooking, cool hardboiled eggs quickly under running cold water or in ice water. Avoid allowing eggs to stand in stagnant water. Refrigerate hard-boiled eggs in their shells promptly after cooling and use them within one week.

• For **microwaved egg dishes**, encourage more even cooking by covering the dish, stirring the ingredients, if possible, and if your microwave does not have a turntable, rotate the dish once or twice during the cooking time.

Recipes calling for raw or lightly cooked eggs. Although the overall risk of egg contamination is very small, the risk of foodborne illness from eggs is highest in raw and lightly cooked dishes. To eliminate risk and ensure food safety, replace all your recipes calling for raw or lightly cooked eggs with cooked egg recipes or use pasteurized shell eggs or egg products when you prepare them. To cook eggs for these recipes, use the following methods to adapt your recipes:

Cooking whole eggs for use in recipes. Fully cook whole eggs for assured safety in recipes that call for raw or lightly cooked eggs. You can use the following method for a variety of recipes, with any number of eggs.

In a heavy saucepan, stir together the eggs and either sugar, water or another liquid from the recipe (at least 1/4 cup sugar, liquid or a combination per egg). Cook over low heat, stirring constantly, until the egg mixture coats a metal spoon with a thin film or reaches 160°F (71°C). Immediately place the saucepan in ice water and stir until the egg mixture is cool. Proceed with the recipe.

Cooking egg yolks for use in recipes. Cook egg yolks for use in mayonnaise, Hollandaise sauce, Caesar salad dressing, cold soufflés, chiffons and mousses and other recipes calling for raw egg yolks. You can use the following method with any number of yolks.

In a heavy saucepan, stir together the egg yolks and the liquid from the recipe (at least 2 tablespoons liquid per yolk). Cook over very low heat, stirring constantly, until the yolk mixture coats a metal spoon with a thin film, bubbles at the edges or reaches 160°F (71°C). Immediately place the saucepan in ice water and stir until the yolk mixture is cool. Proceed with the recipe.

Cooking egg whites for use in recipes. For full safety in all recipes, cook egg whites before you use them. You can use the following method with any number of whites, including chilled desserts and Seven-Minute Frosting, Royal Icing and other frosting recipes calling for raw egg whites.

In a heavy saucepan, the top of a double boiler or a metal bowl placed over water in a saucepan, stir together the egg whites and the sugar from the recipe (at least 2 tablespoons sugar per white), water (1 teaspoon per white) and cream of tartar (1/8 teaspoon per each 2 whites). Cook over low heat or simmering water, beating constantly with a portable mixer at low speed, until the whites reach 160°F (71°C). Pour into a large bowl. Beat on high speed until the whites stand in soft peaks. Proceed with the recipe.

Note that you must use sugar to keep the whites from coagulating too rapidly. Test with a thermometer as there is no visual clue to doneness. If you use an unlined aluminum saucepan, eliminate the cream of tartar or the two will react and create an unattractive gray meringue.

The egg whites in an Italian meringue (made by adding hot sugar syrup to egg whites while beating them) do not reach much above 125°F (52°C), so this method is only safe in dishes that are further cooked. However, if you bring the sugar syrup all the way to the hard ball stage (250° to 266°F/121° to 130°C), the whites will reach a high enough temperature. You can use a sugar syrup at hard ball stage for Divinity and similar recipes.

– See *Cooking Methods, Egg Safety, Fight BAC!, Partnership for Food Safety Education, Raw Eggs, Salmonella*

Double-yolked Eggs

– See *Yolk, Formation, Ovary*

Dried Eggs

– See *Egg Products*

Easter Eggs

Eggs were colored, blessed, exchanged and eaten as part of the rites of spring long before Christian times. Even the earliest civilizations held springtime festivals to welcome the sun's rising from its long winter sleep. Ancient peoples thought of the sun's return from darkness as an annual miracle and they regarded the egg as a natural wonder and a proof of the renewal of life. As Christianity spread, the egg was adopted as a symbol of Christ's Resurrection from the tomb.

For centuries, eggs were among the foods forbidden by the church during Lent, so it was a special treat to have them again at Easter. In Slavic countries, baskets of food including eggs are traditionally taken to church to be blessed on Holy Saturday or before the Easter midnight Mass, then taken home for a part of Easter breakfast.

People in Eastern European countries have a long tradition of elaborately decorating Easter eggs. Polish, Slavic and Ukrainian people create amazingly intricate designs on the eggs. They draw lines with a wax pencil or stylus, dip the egg in color and repeat the process many times to make true works of art. Every dot and line in the pattern has a meaning. Yugoslavian Easter eggs bear the initials “XV” for “Christ is Risen”, a traditional Easter greeting.

The Russians, during the reign of the Tsars, celebrated Easter much more elaborately than Christmas, with Easter breads and other special foods and quantities of decorated eggs given as gifts. The Russian royal family carried the custom to great lengths, giving exquisitely detailed jeweled eggs made by goldsmith Peter Carl Fabergé from the 1880s until 1917.

In Germany and other countries of central Europe, eggs that go into Easter foods are not broken, but emptied out. The empty shells are painted and decorated with bits of lace, cloth or ribbon, then hung with ribbons on an evergreen or small leafless tree. On the third Sunday before Easter, Moravian village girls used to carry a tree decorated with eggshells and flowers from house to house for good luck. The eggshell tree is one of several Easter traditions carried to America by German (Deutsch) settlers, especially those who became known as Pennsylvania Dutch. German immigrants also brought the fable that the Easter bunny delivers colored eggs for good children.

Easter is an especially happy time for children and many Easter customs are for their enjoyment. Hunting Easter eggs hidden around the house or yard is a widespread activity and so are egg-rolling contests.

– *See Decorating Eggs, Empty Eggshells, Games*

Eclairs

– *See Cream Puffs*

Eggnog

A beverage of eggs, milk, sugar and sometimes flavoring. Rich cream may take the place of part or all of the milk and spirits are often added at holiday time. Eggnog may be served hot or cold, but it should be prepared as a cooked stirred custard. The name may come from the noggin or small cup in which it was served in earlier days. Visit www.IncredibleEgg.org for an Eggnog recipe.

– *See Custard, Doneness Guidelines, Cooking Whole Egg for Use in Recipes, Egg Safety, Raw Eggs*

Egg Nutrition Center

The nutrition organization for the egg industry. American Egg Board began to fund ENC in 1984 to provide scientifically correct information on egg nutrition and accompanying health issues. Located in Park Ridge, IL, the Egg Nutrition Center communicates regularly with industry, the media, and health and nutrition communities.

A panel of independent scientists advises the Egg Nutrition Center on the interpretation of research studies. The Center is dedicated to providing scientifically accurate, up-to-date information on egg nutrition and health issues. The Egg Nutrition Center’s website can be accessed at: www.eggnutritioncenter.org

– *See American Egg Board*

Egg Products

Processed and convenience forms of eggs for commercial, foodservice and home use, including refrigerated liquid, frozen, dried and specialty products. Egg products are comparable to shell eggs in flavor, nutritional value and most functional properties. Convenience foods – such as cake and pudding mixes, pasta, ice cream, mayonnaise, candies and bakery goods – utilize egg products. Egg products are frequently preferred to shell eggs by commercial bakers, food manufacturers and the foodservice industry because they have many advantages, including convenience, labor savings, minimal storage requirements, ease of portion control, and product quality, safety, stability and uniformity.

Surplus shell eggs, as well as those produced particularly for the purpose, are used in making egg products. About 30% of total U.S. egg production goes into egg products. About three billion pounds of all types of egg products are produced each year in the U.S.

Since passage of the Egg Product Inspection Act (EPIA) in 1970, all plants that make egg products operate under continuous USDA inspection. The Act mandates specific inspection requirements for shell eggs and egg products to ensure wholesomeness, including pasteurization of all egg products.

Processing egg products. Immediately on delivery to the breaking plant, shell eggs are held in refrigerated holding rooms. Before breaking, the eggs are washed in water that is at least 90°F (32°C). The wash water must also be at least 20°F (-7°C) warmer than the internal temperature of the eggs. The eggs must be sprayrinsed with a sanitizing agent.

Refrigerated liquid products. Machines break eggs and, if necessary, separate the whites and yolks. After the liquid egg is pasteurized and put into covered containers, it may be shipped to bakeries or other outlets for immediate use or to other plants for further processing. When shipped by truckload, sanitary tank trucks maintain temperatures low enough to assure that the liquid egg arrives at its destination at 40°F (4°C) or less.

In addition to tanker truckloads, wholesale and foodservice refrigerated-product containers range in size from bags containing a few ounces to 20-, 30- and 45-pound bags, 4- to 10-pound cartons, 30-pound cans and bulk totes holding up to 3,000 pounds. Retail refrigerated products for home use are generally available in one- or two-pack cartons containing 8 to 16 ounces each.

Keep liquid egg products under refrigeration and use immediately after opening. Shelf life can vary, so check the product label.

Frozen egg products. These products include separated whites and yolks, whole eggs, blends of whole eggs and yolks or whole eggs and milk and these same blends with salt, sugar or corn syrup added. Salt or carbohydrates are sometimes added to yolks and whole eggs to prevent yolk gelation during freezing. Frozen egg products are generally packed in 30- and 40-pound plastic pails, 30-pound cans, and in 4-, 5-, 8- and 10-pound pouches (some of which are cook-in-bag pouches) or waxed or plastic cartons. Some retail consumer products are available frozen in one- or two-pack cartons containing 8 to 16 ounces each.

Keep frozen egg products frozen or refrigerated until use. Thaw frozen egg products under refrigeration or under cold running water in unopened containers. After defrosting, refrigerate thawed egg products and use within 3 days.

Dried or dehydrated egg products. Known also as egg solids, dried egg products have been produced in the United States since 1930. Demand was minimal until World War II when production reached peak levels to meet military and lend-lease requirements. Presentday technology – such as glucose removal and improved multi-stage dryers – has greatly improved the quality of dried eggs. Dried egg products are used in a wide number of convenience foods and in the foodservice industry.

Dried eggs for foodservice are sold in 6-ounce pouches, and 3- and 25-pound poly-packs. For commercial use, 5-, 25- and 50- pound boxes and 150-, 175- and 200-pound drums are available. For home use, dried egg products include dried egg whites in 3- to 8-ounce fiberboard and metal canisters sold in supermarkets, meringue powders often available at gourmet outlets and freeze-dried egg products found in camping goods stores.

Unopened dried egg products may be stored at room temperature as long as they are kept cool and dry. Tightly seal and refrigerate opened containers. Reconstituted egg products should be used immediately or refrigerated and used that day.

Specialty egg products. Egg specialties processed for the foodservice industry include wet- and dry-pack, pre-peeled, hard-boiled eggs – either whole, wedged, sliced, chopped or pickled; long rolls of hard-boiled eggs; and freeze-dried scrambled eggs. Among other convenience menu items, also available are a host of frozen products, including precooked fried and scrambled eggs and scrambled egg mix in boilable pouch, omelets, egg patties, French toast, quiche and quiche mix. Ultra-pasteurized liquid eggs with extended shelf-life are also available.

Many specialty egg items are also available at retail, including refrigerated peeled, hard-boiled eggs; shelf-stable pickled eggs; and frozen scrambled eggs, omelets and mixes, French toast and quiche.

– See *Breakers, Egg Products Inspection Act, Restricted Eggs*

Egg Products Inspection Act

The Egg Products Inspection Act assures that eggs and egg products distributed and consumed by the public are wholesome, not adulterated, and properly labeled and packaged. Passed by Congress in 1970, the Egg Products Inspection Act is administered by the U.S. Department of Agriculture (USDA) and imposes specific inspection requirements for two categories of eggs – shell eggs and egg products. Under the Egg Products Inspection Act, plants that break, dry and process shell eggs into liquid, frozen or dried egg products must operate under the continuous inspection program of the USDA. The law does not apply to foodmanufacturing plants which prepare cooked eggs or other food products made with eggs or egg products, such as those which make mayonnaise, egg noodles and ice cream, for example. An official inspector must be present at all times when eggs are being processed.

– See *Egg Products, Grading, Restricted Eggs*

Egg Roll

1. An elongated, hard-boiled egg processed for the foodservice industry. When the roll is sliced, every piece is a center cut for attractive service. – See Egg Products
 2. An Asian specialty consisting of a savory filling wrapped in an egg-rich dough, then deep-fat fried. In the U.S., egg rolls are usually served as appetizers.
 3. An annual Easter event held in many venues, including the White House lawn.
- See *Egg Games*

Egg Safety

Clean hands and equipment, sanitary food-handling practices, proper cooking and adequate refrigeration are essential in preparing all foods, including eggs, prior to eating. The contents of raw shell eggs may contain the bacteria *Salmonella Enteritidis*, but common food-safety practices can reduce the risk of illness. Use only refrigerated, clean, uncracked, fresh Grade AA or A eggs and follow these important food-handling practices:

Clean. Clean all cooking equipment and food-contact surfaces you use in food preparation. Always wash your hands before and after cracking open raw eggs and wash frequently during food preparation. Use soap and warm water and rub your hands together for 20 seconds, then dry thoroughly.

Separate. As the kitchen can also be a source of bacteria, to avoid crosscontamination, clean all cooking equipment and food-contact surfaces. Also avoid mixing egg yolks and whites with the shell.

Cook. Proper heating destroys the bacteria of concern in eggs. Cook eggs until the whites and yolks are firm and cook egg-containing dishes to an internal temperature of 160°F (71°C)

Chill. Always refrigerate eggs in their original carton in the main section of the refrigerator. Use a refrigerator thermometer to make sure the refrigerator temperature is between 33° to 40°F (1° to 4°C). If you accidentally leave eggs, egg mixtures or cooked egg dishes at room temperature, discard them after two hours or one hour (when the temperature outside is 90°F (32°C) or warmer. For summer outings, use ice or coolant in an insulated bag or cooler to keep cold foods cold (40°F/4°C or lower) and thermal containers to keep hot foods hot (140°F/60°C or higher). When you tote raw eggs on outings, leave them in their shells. E 41

– See *Cooking Methods, Doneness Guidelines, Fight BAC!, Partnership for Food Safety Education, Raw Eggs, Salmonella, Egg Safety Center*

Egg Safety Center

Under the administration of United Egg Producers, the Egg Safety Center (ESC) provides scientifically accurate information on egg safety issues to both consumers and egg producers. ESC also answers any questions that consumers, producers, or media may have on eggs and egg safety as well as provides real-time updates on recalls that include eggs or egg products.

– See *Egg Safety*

Egg Salad

A popular combination of chopped hard-boiled eggs, a dressing – such as mayonnaise – and seasonings. Egg salad is often served as a sandwich filling or in tomato or lettuce cups.

Eggs Benedict

Poached eggs with Canadian bacon served on English muffins with Hollandaise Sauce.

Egg Substitutes

Liquid egg products that typically contain only egg white with the yolk replaced by other ingredients, such as non-fat milk, tofu, vegetable oil, emulsifiers, stabilizers, antioxidants, gum, artificial color, minerals and vitamins. Egg substitutes contain the high-quality protein of egg white as well as the white's vitamins and minerals. However, each formula for replacing the yolk differs, so check labels for total nutrient content.

Due to varying formulas, each brand of egg substitute performs differently in cooking. You may have to experiment to learn how to cook an individual brand. For instance, those brands without fat will cook more quickly than those containing fat. Common to all brands is that the yolk's cooking properties, including emulsification, are lost. All brands which contain fat retard egg-white foaming which is needed to leaven certain dishes. Since both emulsification and leavening are important in many baked goods, egg substitutes may not yield the same results as shell eggs in home baking.

Egg White

– See *Albumen*

Empty Eggshells

Shells from which the edible part of the egg has been emptied. With nothing inside to spoil, you can decorate empty eggshells and keep them indefinitely.

To empty an eggshell, first wash the egg, using water warmer than the egg, and dry it. With a sterilized long needle or small, sharp skewer, prick a small hole in the small end of the egg and a large hole in the large end. Carefully chip away bits of shell around the large hole until it's big enough to accommodate the tip of a baster. Stick the needle or skewer into the yolk to break it.

Either shake the egg large-end down over a cup or bowl until the contents come out or use a baster to push out the contents. Press the bulb of the baster to push air into the egg, letting the contents fall into the cup. If the contents don't come out easily, insert the needle again and move it around to be sure both the shell membranes and yolk are broken. Rinse the empty shell under cool running water and stand it on end to drain and dry. Be careful when decorating emptied shells – they're quite fragile.

Use the contents of emptied eggshells immediately in a recipe which includes mixed yolks and whites and calls for thorough cooking. Most baked dishes – such as casseroles, custards, quiches, cakes or breads – are good uses for eggs emptied from their shells.

Equinox

Either of the two times each year when the sun crosses the equator and day and night are of equal length everywhere. It is said that an egg will stand on its end during the spring (vernal) equinox (about March 21). Depending on the shape of the egg, you may be able to stand it on its end other days of the year as well.

Expiration Date

A date on an egg carton beyond which the eggs should not be sold.
– See *Carton Dates, Julian Dates*

Fat

A concentrated source of food energy containing 9 calories per gram. In addition to supplying energy, fat aids in the absorption of certain vitamins; enhances flavor, aroma and mouthfeel of food; and adds satiety to the diet. Fatty acids, the basic chemical units of fat, are either saturated, monounsaturated or polyunsaturated. Saturated fatty acids are found primarily in fats of animal origin (meat, poultry, fish, seafood, milk and their products) and are usually solids at room temperature. Exceptions are some vegetable oils (palm, palm kernel and coconut) which contain large amounts of saturated fatty acids.

Saturated fatty acids increase blood cholesterol levels. Monounsaturated fatty acids are found in fats of both plant and animal origin and tend to improve blood cholesterol levels. Polyunsaturated fatty acids are found primarily in fats of plant origin and in fats of fatty fish and also tend to improve blood cholesterol levels. When monounsaturated or polyunsaturated fats are chemically hydrogenated, they become more solid trans-fatty acids. Trans-fatty acids tend to increase the levels of harmful LDL (low-density lipoprotein) cholesterol and decrease the levels of helpful HDL (high-density lipoprotein) cholesterol in the blood.

Most nutrition professionals recommend that we reduce our total dietary fat to 30% or less of total calories and that we limit our saturated fat intake to less than 10% of total calories. They emphasize that most of the fat in our diets should come from monounsaturated and polyunsaturated fats, including omega-3 fatty acids.

A large egg contains about 4.8 grams of fat – about 1.6 grams saturated and 2.8 grams unsaturated – and is considered a medium-fat food. You can keep added fats, especially saturated fats, to a minimum by using low-fat cooking methods and serving eggs with fruits, vegetables, whole-grain foods and low-fat milk products.

– See *Cholesterol, Cooking Methods, Omega-3 Fatty Acids*

Fertile Eggs

Eggs which have been fertilized, can be incubated and developed into chicks, as long as the eggs are not refrigerated. Nearly all commercially produced eggs are laid by hens which have not mated with a rooster, so are not fertilized.

Fertile eggs are no more nutritious than nonfertile eggs, do not keep as well as nonfertile eggs and are more expensive to produce. Although fertile eggs may contain a small amount of the rooster's male hormone, scientists believe it's more likely that the hormone dissipates. Some ethnic groups consider fertile eggs a delicacy.

– *See Germinal Disc*

Fight BAC!

A food safety program of the nonprofit Partnership for Food Safety Education.

– *See Partnership for Food Safety Education*

Flan

- *See Custard-Baked*

Floating Eggs

Eggs can float in water when the air cell has enlarged enough to keep it buoyant. This means the egg is old, but it may be perfectly safe to use. Crack the egg into a bowl and check for an off-odor or unusual appearance - a spoiled egg will have an unpleasant odor when you break open the shell, either when raw or cooked.

Floating Islands

– *See Meringues- Poached Meringues*

Foam

Air bubbles trapped in a mixture. A foam is created by incorporating air, usually by beating, and capturing the air in tiny bubbles. Eggs are excellent at foam formation. You can beat egg whites, egg yolks or whole eggs into a foam.

When you beat egg white, it becomes foamy, increases 6 to 8 times in volume and stands in peaks. When you heat the foam, the tiny air cells expand and the egg protein coagulates around them, giving permanence to the foam. Egg-white foam is responsible for the structure of angel food cake, meringues, puffy omelets and soufflés.

For egg whites that reach their greatest volume, allow the whites to stand at room temperature for about 30 minutes before beating.

Fat inhibits the foaming of egg whites, so be sure beaters and bowls are clean and that there's no trace of yolk in the whites. Use only metal or glass bowls because plastic bowls tend to absorb fat.

Adding an acid ingredient helps to stabilize egg-white foam. The most commonly used acid ingredient is cream of tartar (1/8 teaspoon for each 1 to 2 whites) although some recipes call for lemon juice or vinegar. Opinion among food scientists is divided on salt. Since salt may decrease foam stability, it's best to add it to other recipe ingredients.

If you underbeat egg whites, the volume of the finished product will be less than desired. Overbeaten whites form clumps which are difficult to blend with other ingredients. Because overbeaten egg whites also lack elasticity, they can't expand properly when heated. The finished product may be dry or have poor volume, or may even collapse.

Combine an egg-white foam with other ingredients immediately after beating, before the foam has time to drain or shrink.

An egg-yolk foam may double or triple in volume but doesn't reach nearly the volume of egg-white foam. Beaten yolk foam is an important part of the leavening for puffy omelets and sponge cakes and is sometimes also used for soufflés.

Whole egg will also form a foam, but the volume is much less than the foam of beaten white and the foam is less thick than the foam of beaten yolk.

– *See Angel Food Cake, Cooking Terms, Meringue*

Formation

A hen requires about 24 to 26 hours to produce an egg. After the egg is laid, the hen starts all over again about 30 minutes later.

The hen's reproductive system consists of the ovary, the organ where the yolk develops, and the oviduct where the egg is completed. The ovary is attached to the hen's back, about halfway between the neck and the tail. The oviduct, a tubelike organ about 26 inches long, is loosely attached to the backbone between the

ovary and the tail. Most female animals have two functioning ovaries, but the hen uses only one, the left. The right ovary and oviduct remain dormant.

Ovary

A female chick is born with a fully formed ovary containing several thousand tiny ova, or future yolks. The ova begin to develop, one at a time, when the pullet (a hen less than 1 year old) reaches sexual maturity. Each yolk is enclosed in its own sac or follicle.

The follicle contains a highly developed system of blood vessels which carry nourishment to the developing yolk. Typically, about 30 minutes after the last egg was laid, ovulation occurs. At ovulation, the follicle ruptures to release the yolk into the oviduct. A double-yolked egg results when two yolks are released at the same time. Rupture occurs at the stigma line, an area of the follicle which has no blood vessels.

– See *Blood Spots*

Oviduct

The infundibulum, also known as the funnel, captures the ovulated yolk. The infundibulum is where fertilization, if it occurred, would take place. After about 15 minutes, the yolk passes along to the magnum where, in about 3 hours, the hen deposits the albumen (white) around the yolk. As the albumen (white) is formed, the yolk rotates, twisting the albuminous fibers to form the chalazae. Next, in about 1-1/4 hours, the two shell membranes are formed and some water and minerals are added in the isthmus.

The egg has now reached its full size and shape and passes along to the uterus (shell gland) where, after 19 to 21 hours, it acquires its shell, shell color and bloom. After a few minutes' pause in the vagina, the uterus inverts through the vagina, the cloaca (the junction of the digestive, urinary and reproductive systems) and the vent to release the egg outside the hen's body. Laying of the egg is known as oviposition.

During formation, the egg moves through the oviduct small end first. Just before laying, the egg rotates to be laid large end first. A young hen lays small eggs. The size increases as she gets older.

– See Bloom; Chalazae;

Freezing Eggs

If you have more eggs than you can use within a few weeks of buying them, you can break them out of their shells and freeze them. Freeze only clean, fresh eggs.

Whites

Break and separate the eggs, one at a time, making sure that no yolk gets in the whites. Pour the whites into freezer containers, seal tightly, label with the number of egg whites and the date, and freeze. For faster thawing and easier measuring, first freeze each white in a standard ice cube tray. Then transfer to a freezer container.

Yolks

The gelation property of egg yolk causes it to thicken or gel when frozen, so you need to give yolks special treatment. If you freeze them as they are, egg yolks will eventually become so gelatinous that they will be almost impossible to use in a recipe. To help retard this gelation, beat in either 1/8 teaspoon salt or 1-1/2 teaspoons sugar or corn syrup per 1/4 cup of egg yolks (about 4 yolks). Label the container with the number of yolks, the date, and whether you've added salt (for main dishes) or sweetener (for baking or desserts). Freeze.

Whole eggs

Beat just until blended, pour into freezer containers, seal tightly, label with the number of eggs and the date, and freeze.

To use frozen eggs

In a home freezer, you can freeze eggs for up to one year. When you're ready to use frozen eggs, thaw them overnight in the refrigerator or under running cold water. Use egg yolks or whole eggs as soon as they're thawed. Thawed egg whites will beat to better volume if you allow them to sit at room temperature for about 30 minutes. Use thawed frozen eggs only in dishes that are thoroughly cooked.

Hard-boiled eggs

You can freeze hard-boiled egg yolks to use later for toppings or garnishes. Carefully place the yolks in a single layer in a saucepan and add enough water to come at least 1 inch above the yolks. Cover and quickly bring just to boiling. Remove the pan from the heat and let the yolks stand, covered, in the hot water about 12

minutes. Remove the yolks with a slotted spoon, drain them well and package them for freezing. It's best not to freeze hard-boiled whole eggs and hard-boiled whites because they become tough and watery when frozen.

French Toast

Egg- and milk-soaked bread, fried or oven-baked. The French call this popular dish *pain perdu*, lost bread. In the 15th century, thrifty cooks developed this recipe concept to revive nearly stale bread, which would otherwise have been lost. Eggs also serve to soften dry bread in bread puddings and stratas.

– *See Strata, Bread Pudding*

Freshness

How recently an egg was laid has a bearing on its freshness but is only one of many factors. The temperature and humidity level at which the egg is held play their parts as well. These variables are so important that an egg one week old, held under ideal conditions, can be fresher than an egg left at room temperature for one day. The ideal conditions for egg storage are temperatures between 35° and 40°F (2° to 4°C) and a relative humidity of 70 to 80%.

Proper handling means promptly gathering and washing the eggs within a few hours after they've been laid. Most commercially produced eggs reach supermarkets within a few days of leaving the laying house. If you and your market handle eggs properly, they'll still be fresh when they reach the table.

It's a misconception that you can judge freshness by placing an egg in salt water. A carefully controlled brine test is sometimes used to judge shell thickness of eggs for hatching purposes but the test has no application to freshness of table eggs.

How important is freshness? As an egg ages, the white becomes thinner, the yolk becomes flatter and the yolk membrane becomes weaker. These changes don't have any great effect on the nutritional quality of the egg or its functional cooking properties in recipes. Appearance may be affected though. When poached or fried, the fresher the egg, the more it will hold its shape rather than spread out in the pan. However, if you hard-boil eggs that are at least a week old, you'll find them easier to peel than fresher eggs. The stronger the yolk membrane, the less likely the yolk will break inadvertently.

– *See Storing*

Fried Egg

– *See Cooking Methods, Fried*

Frittata

A pan-sized, unfolded Italian omelet in which all the ingredients cook right in the omelet. You can flavor a frittata with any combination of cooked foods you like – vegetables, grains, meat, poultry, fish, seafood or cheese. Start cooking the egg and filling mixture on top of the range until it's almost set. Then, you can finish cooking the top of the frittata by putting the pan under the broiler or in the oven. Or you can flip the frittata out of the pan upside down onto a plate and then slide it back into the pan to cook the other side. The easiest way is simply to remove the pan from the heat, cover it and let steam finish the cooking.

– *See Tortilla*

Games

The egg's fragility probably accounts for its popularity in games down through the centuries.

Egg Hunt

Hiding colored or decorated eggs around the house or garden for children to find has long been an Easter morning tradition. In addition to private-home egg hunts, some organizations and communities hold very large public egg hunts.

Egg Toss

Along with a sack race, an egg toss is a popular picnic game. In an egg toss, partners line up in two rows facing each other. Every member on one side tosses a raw egg across. After each successful catch, the players step backward, adding to the difficulty of the next catch. This is repeated until all but one egg is broken. The pair with the last unbroken egg wins.

Egg Rolling

According to the White House Historical Association, the traditional egg rolling that takes place on the lawn of the White House or Capitol building started in 1878. President and Mrs. Hayes invited children to play at the White House when they were turned away from the Capitol building. Similar events are held in many other locations throughout the country. The United States, however, can't take credit for inventing the custom. Egg rolling was mentioned in a Latin treatise in 1684. Many variations of egg rolling contests and games are played. In England and Scotland, children roll eggs downhill and the last child with an unbroken egg is the winner. In another version of egg rolling, the players push the egg to the finish line using only their noses. Very similar are egg races in which the players try to send emptied eggshells across the finish line by fanning them with a piece of cardboard or by blowing them. Since eggs are not round, winning is not as easy as it might seem.

Egg Tapping

Many countries continue the age-old ritual of egg tapping or eggshackling. For example, Greeks form a circle and tap scarlet eggs, one against the other. The one finishing with an unbroken egg may claim all the other eggs. (The trick is protecting as much of the egg as possible with your fingers.)

Pace Egging

Up until modern times, children in English villages carried on an old sport called pace-egging. The name comes from Pasch, which means Easter in most European countries. This derives from Pesach, the Hebrew Passover which falls at the same time of the year. Similar to Halloween trick-or-treaters, pace-eggers went from house to house in costume or with paper streamers and bright ribbons attached to their clothes. Faces blackened or masked, they sang or performed skits and demanded pace-eggs, either colored hardboiled eggs or substitutes such as candy and small coins. – See *Decorating Eggs, Easter Eggs*

Germinal Disc

The entrance of the latebra, the channel leading to the center of the yolk. The germinal disc is barely noticeable as a slight depression on the surface of the yolk. If an egg is fertilized, sperm enter through the germinal disc, travel to the yolk center and a chick embryo starts to form.

– See *Composition, Formation*

Gluten Free

All eggs are naturally gluten free. If a chicken is fed a grain that contains gluten, i.e. corn, wheat or barley, the gluten is broken down during 50 G the digestive process (within the chicken) and is not passed into the body tissues or any products produced by the chicken.

Gougère

– See *Cream Puff*

Grading

Classification determined by the interior and exterior quality of the egg at the time it is packed. In some egg-packing plants, the U.S. Department of Agriculture (USDA) provides a voluntary grading service for shell eggs. The official USDA grade shield on an egg carton certifies that the eggs have been processed, packaged and certified under federal supervision according to the U.S. Standards, Grades and Weight Classes for Shell Eggs established by USDA. Plant processing equipment, facilities, sanitation and operating procedures are continuously monitored by the USDA egg grader.

In the grading process, eggs are examined for both interior and exterior quality before they're sorted according to weight (size). Grade quality and weight (size) are not related to one another. Eggs of any quality grade may differ in weight (size). In descending order of quality, grades are designated AA, A and B.

Exterior Quality

The first step in egg grading is to examine the shell for cleanliness, soundness, texture and shape. Shell color isn't a factor in judging quality. All eggs must be clean to pass grading requirements, but a small amount of staining is permitted in Grade B. All eggs must have unbroken shells. Eggshells with cracks or markedly unsound, or flawed, shells are classified as restricted eggs. The ideal eggshell shape is oval with one end larger than the other. Abnormal shells, permitted for Grade B eggs, may be decidedly misshapen or faulty in texture with ridges, thin spots or rough areas.

Interior Quality

The next step in grading is examination of the interior of the egg. This is done by candling or by the breakout method using the Haugh unit system to evaluate the albumen, yolk and air cell (not done in commercial processing). Albumen (white) is judged on the basis of clarity and firmness or thickness. A clear albumen is free from discolorations or from any floating foreign bodies. When an egg is rotated over the candling light, its yolk swings toward the shell. The distinctness of the yolk outline depends on how close to the shell the yolk moves, which is influenced by the thickness of the surrounding albumen. Thick albumen permits limited yolk movement while thin albumen permits greater movement – the less movement, the thicker the white and the higher the grade. Factors determining yolk quality are distinctness of outline, size and shape and absence of such defects as blemishes or mottling, embryo development or blood spots. Highergrade eggs have shallower air cells. In Grade AA eggs, the air cell may not exceed 1/8 inch in depth and is about the size of a dime. Grade A eggs may have air cells over 3/16 inch in depth. There is no limit on air cell size for Grade B eggs.

While air-cell size is considered in grading and eggs take in air as they age, the size of the air cell does not necessarily relate to freshness because size varies from the moment contraction occurs after laying. To judge freshness, use carton dates.

– See *Air Cell, Blood Spots, Breakout, Buying, Candling, Egg Products Inspection Act, Formation, Haugh Unit, Restricted Eggs, Shell, Yolk*

Greening

– See *Color, Yolk*

Hard-Boiled/Hard- Cooked Egg

– See *Cooking Methods, Hard-Boiled, Cooking Equipment, Cooker, Piercer, Slicer, Wedger; Decorating Eggs, Deviled Eggs, Egg Salad, Freezing, Peeling, Storing*

Haugh Unit

A measurement used in determining albumen (white) quality by the breakout method. The test is named for Raymond Haugh who introduced it in 1937.

– See *Breakout*

High Altitude

–See *Cooking Methods*

History

East Indian history indicates that wild jungle fowl were domesticated as early as 3200 BC. Historians also note that the fowl were eaten more often than the eggs, since the eggs were saved to hatch to keep the fowl in supply. Egyptian and Chinese records show that fowl were laying eggs for man in 1400 BC. Chinese described fowl as “the domestic animal who knows time”, probably due to the dependability of the rooster’s early morning call and the regularity of the hen’s egg production.

Although there is some evidence of native fowl in the Americas prior to his arrival, it is believed that Columbus’ ships carried to this country the first of the chickens related to those now in egg production. These strains originated in Asia.

While the fowl referred to in the earliest histories could include a vast assortment of avian representatives, most people of the world eat, and all information here refers to, the egg of the chicken (*Gallus domesticus*). Nearly 200 breeds and varieties of chickens have been established worldwide, but only a few are economically important as egg producers. Most laying hens in the U.S. are Single-Comb White Leghorns.

Hollandaise Sauce

A rich, lemon-flavored butter sauce thickened with egg yolks. The French chef who created this sauce most likely named it for Holland because Holland was famous for butter, a main ingredient in the sauce. In addition to its use in Eggs Benedict, Hollandaise sauce is often served over asparagus or poached salmon. Many other sauces, such as Béarnaise and Mouseline, are based on Hollandaise sauce. Hollandaise sauce can curdle if even slightly overcooked, so cook it over low heat, stir it constantly, and give it close attention.

Hormones

In the U.S., by federal law, passed into law more than 50 years ago, neither laying hens nor any other type of poultry can be fed hormones. However, eggs contain natural hormones. Therefore, the statement “no hormones” is considered misleading to the consumer. The egg industry does not use hormones in the production of shell eggs. The FDA requires a qualifying statement on the label for shell eggs which is “Hormones are not used in the production of shell eggs”.

Huevos Rancheros

Spanish for rancher’s eggs. Typically fried eggs served over fried corn tortillas and topped with salsa.

Julian Dates

Starting with January 1 as 001 and ending with December 31 as 365, these numbers represent the consecutive days of the year. This number system is sometimes used on egg cartons to denote the day the eggs are packed. You can store fresh shell eggs in their cartons in the refrigerator with insignificant quality loss for four to five weeks beyond this date.

– See *Carton Dates, Expiration Date*

Kosher Eggs

Almost all eggs are Kosher. Under Kosher dietary laws, neutral eggs are considered neither milk nor meat and may be eaten with either. Kosher-certified eggs are produced according to biblical laws governing the selection and preparation of foods. These eggs are produced by hens at egg farms which have been inspected by a rabbi and found to merit the OU designation.

Kugel

Baked custard with noodles or potatoes served as a savory side dish or sweetened for dessert. Traditionally served on Jewish Sabbath meals.

– See *Custard, Baked*

Lecithin

One of the factors in egg yolk that helps to stabilize emulsions such as Hollandaise sauce, mayonnaise and other salad dressings. Lecithin contains a phospholipid called acetylcholine which has been demonstrated to have a profound effect on brain function.

– See *Cooking Functions, Hollandaise Sauce, Mayonnaise, Nutrient*

Lutein

Both lutein and zeaxanthin are carotenoids called xanthophylls, yellow-orange plant pigments. These carotenoids have been shown to reduce the risks of cataracts and age-related macular degeneration, the leading cause of blindness in those 65 and older. Lutein and zeaxanthin accumulate in the eye’s lens and in the macular region of the retina. Scientists believe high levels of lutein and zeaxanthin in these areas may protect the eye from damage due to oxidation.

Lutein and zeaxanthin are commonly found in dark-green leafy vegetables, such as spinach and kale, and are wellabsorbed from egg yolk. A large egg yolk contains 252 mcg of lutein and zeaxanthin (smaller amounts compared to other sources). When hens are fed a diet which includes yellow corn, alfalfa meal, corn-gluten meal, driedalgae meal or marigold-petal meal, xanthophylls are deposited in the yolks. Research has shown that, due to the egg yolk’s fat content, the yolk’s lutein and zeaxanthin may be more easily absorbed by the body than the lutein and zeaxanthin from richer sources. A specific recommendation for daily consumption of these carotenoids has not yet been determined.

Marketing

How eggs get from hen to kitchen. The marketing chain begins at the laying farm where eggs are gathered, packed and refrigerated. On many farms, the grading and packing are done on the farm. At other farms, eggs are picked up several times a week by the grading station’s refrigerated trucks. At the grading station, the eggs are washed, sorted by size, graded for quality and packed into cartons. Ideally, eggs move from the grading station to the store or store warehouse three to five times a week, depending on available storage space. Many large supermarket chains receive all their eggs at warehouses from which the eggs are distributed to individual stores.

Individual retail outlets need both adequate refrigerated space in the back and refrigerated self-service counters out front to merchandise eggs properly.

Sales techniques depend on the local retailer and, sometimes, the supplier. Sales are often stimulated by attractive cartons and point-of-purchase displays as well as advertising and consumer education activities.

Activities of the American Egg Board help to keep consumers aware of the egg as a convenient, versatile, nutritious and economical mealtime staple. State and regional egg promoters inform consumers through lectures, articles, recipes and demonstrations. Advertising and publicity messages help to heighten buyer awareness of the egg and its importance to meal planning.

– See *American Egg Board, Grading*

Marshmallow

A soft confection made from sugar, corn syrup, egg whites and gelatin. In addition to being consumed on their own as a sweet, marshmallows are popularly used as a hot cocoa topping, an ingredient in some ice creams and a base in various candies.

Mayonnaise

A salad dressing made of eggs, oil, lemon juice or vinegar and seasonings. The egg yolk acts as an emulsifying ingredient to keep the oil and lemon juice or vinegar from separating. Mayonnaise is used as a spread, dressing and sauce and as the base for many other preparations, including aioli, rémoulade sauce, tartar sauce and Thousand Island dressing. For food safety in making mayonnaise, cook the egg yolks and the liquid from the recipe over low heat until the mixture reaches 160°F (71°C). Then add the oil to the egg liquid mixture very slowly, so the oil can be properly incorporated.

– See *Doneness Guidelines, Cooking Egg Yolks for Use in Recipes, Partnership for Food Safety Education, Raw Eggs, Salmonella*

Meat Replacement

One egg of any size equals one ounce of lean meat, poultry, fish or seafood from the Protein Foods Group. Along with varying amounts of many other nutrients, one large egg provides 6.28 grams of high-quality, complete protein or about 12.6% of the Daily Reference Value (DRV) for protein.

– See *Biological Value, Buying, Daily Reference Values (DRVs), My Plate, Nutrient, Nutrient Density, Protein*

Membranes

Shell Membranes: Just inside the shell are two shell membranes, inner and outer. After the egg is laid and begins to cool, at the large end of the egg, an air cell forms between these two membranes.

Vitelline Membrane: The strength of this yolk covering protects the yolk from breaking. The vitelline membrane is weakest at the germinal disc and tends to become more fragile as the egg ages.

– See *Air Cell, Composition, Formation, Germinal Disc, Grading*

Meringue

A foam of beaten egg whites and sugar. Egg foams were used in pastries much earlier, but the name meringue came from a pastry chef named Gasparini in the Swiss town of Merhrinyghen. In 1720, Gasparini created a small pastry of dried egg foam and sugar from which the simplified meringue evolved. Its fame spread and Marie Antoinette is said to have prepared the sweet with her own hands at the Trianon in France.

The most critical factor in making meringue is humidity. Because it has a high sugar content, meringue can absorb moisture from the air and become limp and sticky. For best results, make meringue on a bright, dry day.

Be sure that beaters and bowls are clean and completely free of fat or oil because the least bit of fat will prevent beaten egg whites from reaching their full volume. As plastic bowls tend to absorb fat, use only metal or glass bowls.

After separating eggs, allow the whites to stand at room temperature about 20 to 30 minutes before beating so they will reach their fullest volume.

Beat the whites with cream of tartar, using 1/8 teaspoon for each 2 egg whites, until foamy. (Cream of tartar lends stability to egg foams.) When foamy, gradually beat in the sugar, 1 to 2 tablespoons at a time. Continue beating until the sugar is dissolved and soft peaks form. (If the sugar is not completely dissolved, the meringue will be gritty. Rub just a bit of the meringue between your thumb and forefinger to feel if the sugar has dissolved).

There are several kinds of meringues; each suited to a special use. The differences are in the ratio of egg whites to sugar, the method of mixing or the method of cooking.

Soft Meringue

Used to top pies and puddings. The usual ingredient ratio is 2 tablespoons of sugar to each egg white. Beat the meringue until soft peaks form, then swirl it over a hot, precooked pie filling or pudding. Sometimes, after baking, liquid accumulates between the meringue and the filling. You can minimize this weeping if the filling is hot when you put the meringue on it. To keep a pie meringue from shrinking during baking, make sure the meringue touches the edge of the crust or the dish all around. A 3-egg-white meringue will cover a 9-inch pie. In a preheated 350°F (177°C) oven, bake a pie topped with a 3-egg-white meringue until the meringue reaches 160°F (71°C) and the meringue peaks are lightly browned, about 12 to 15 minutes. For a meringue containing more egg whites, bake in a preheated 325°F (163°C) oven until the meringue reaches 160°F (71°C) and the peaks are lightly browned, about 25 to 30 minutes. After cooling, refrigerate meringuetopped pies until serving and return leftovers to the refrigerator.

Hard or Swiss Meringue

Used as a confection or a foundation for fillings of fruits or puddings. The usual ingredient ratio is 4 tablespoons of sugar to each egg white. Beat until stiff peaks form.

You can bake a meringue on a baking sheet greased with unsalted shortening (not oil) or on a baking sheet lined with parchment paper or aluminum foil. Depending on how you intend to use a hard meringue, you can pipe it through a pastry tube, shape it gently with a spoon or spatula, or bake it in a greased pie plate, cake pan or springform pan.

Meringue baked in a pie plate forms a delicate crust for fillings, such as chocolate or lemon, and the result is often known as Angel Pie. Meringue baked in a cake or springform pan is often served with whipped cream and fruit and is called Schaum Torte or Pavlova.

Depending on the oven temperature and baking time, you can vary the texture of the finished meringue from dry and crisp to chewy. If you bake or, more properly, dry, a meringue in a preheated 225°F (107°C) oven for 1 to 1-1/2 hours until a cake tester or wooden pick inserted in the center comes out clean, it will be white, dry and crisp. For complete drying, turn off the oven and leave the meringue in the oven for at least an hour longer. Dry a shorter time to produce a chewier center. For a light golden hue, bake at 250°F (121°C) for less time or until the center is done as you wish.

You can store hard meringues for several months in a tightly sealed container with waxed paper between the layers. If the meringue loses its crispness, reheat it in a preheated 250°F (121°C) oven for 15 to 20 minutes.

Italian Meringue

Also known as Boiled Frosting and used to frost cakes, as a topping like soft meringue or as a base for frozen desserts and may also be baked like hard meringue or poached. When folded into whipped cream, Italian meringue becomes Chantilly Meringue, which may be combined with fruit as a filling for cream puffs or used as a frosting. To make Italian meringue, beat hot sugar syrup into beaten, cooked egg whites.

– *See Raw Eggs*

Poached Meringues

Also known as Snow Eggs or Oeufs à la Neige and often served with custard or fruit sauce. Poached meringues are also the islands in Floating Island Pudding. You can poach soft, hard and Italian meringue mixtures.

To poach, drop the meringue mixture by spoonfuls onto simmering milk or water and simmer, uncovered, until firm, about 5 minutes. You don't need to turn over smaller spoonfuls but large ones may require turning halfway through the cooking time. Remove the poached puffs from the liquid with a slotted spoon and drain them on absorbent paper. Chill the poached meringues until you serve them.

Microwave Cooking

Incredible edible eggs, nature's own convenience food, and the microwave oven add up to quick and easy meals with a minimum of clean up. Despite all its attributes, though, the microwave oven doesn't do justice to airy soufflés or puffy omelets. These dishes need the dry heat of a conventional oven to puff beautifully.

For successful eggs in the microwave, keep these few points in mind:

Egg yolk, because it contains fat, tends to cook more quickly than egg white so omelets, scrambled eggs and dishes where the eggs are beaten cook more evenly in the microwave oven than do other egg preparations.

They can also be cooked using full power (high).

Size of eggs matters even more in a microwave, when using a jumbo egg instead of a large-size egg, additional time may be needed.

Use minimum times when cooking eggs in the microwave, as they are easily overcooked. Add time in small increments, 10 to 15 seconds, to prevent overcooking. And remember, eggs will continue to cook and firm up after they are removed from the microwave. To encourage more even cooking, cover microwave cooking containers; stir the ingredients, if possible; and, if your oven doesn't have a turntable, rotate the dish during cooking.

Never microwave an egg in its shell because it will explode. Even out of the shell, eggs may explode in the microwave because rapid heating causes steam to build up under the yolk membrane faster than it can escape.

Microwave Recipes

NOTE: Microwave ovens vary. Cook time may need to be adjusted.

MICROWAVE ONE EGG SCRAMBLE: Beat 1 large egg and 1 tablespoon water in 8-oz. white ramekin or 6-oz. custard cup until blended. Microwave on HIGH 30 seconds; stir. Microwave until egg is almost set, 15 to 30 seconds longer. Season with salt and pepper.

MICROWAVE TWO EGG SCRAMBLE: Beat 2 large eggs and 2 tablespoon water in microwave-safe bowl until blended. Microwave on HIGH 45 seconds; stir. Microwave until egg is almost set, 30 to 45 seconds longer. Season with salt and pepper.

MICROWAVE TWO EGG OMELET: Beat 2 eggs, 2 tablespoon water in small bowl until blended. Microwave 1 teaspoon butter in 9-inch glass pie plate on HIGH until melted, about 30 seconds. Tilt plate to coat bottom evenly. Pour egg mixture into hot pie plate. Cover tightly with plastic wrap, leaving a small vent. Microwave on HIGH 1-3/4 to 2 minutes. Do not stir. When top is thickened and no visible liquid egg remains, place shredded cheese or cooked fillings such as diced ham, crisp bacon, sautéed mushrooms, roasted peppers, caramelized onions on one half of the omelet. Fold omelet in half with turner; slide from pie plate onto serving plate. Serve immediately.

MyPlate

MyPlate is part of a larger communications initiative based on the 2010 Dietary Guidelines for Americans to help consumers make better food choices. MyPlate is designed to remind Americans to eat healthfully.

MyPlate illustrates the five food groups using a familiar mealtime visual, a place setting. For a balanced diet that includes all the food groups in good proportions, you can find recommendations based on your age, gender and activity level at www.choosemyplate.gov/.

Eggs are included in the Protein Foods Group. One egg equals one ounce of lean meat, poultry, fish or seafood. (Three egg yolks = 1 ounce, 3 egg whites = 2 ounces).

Natural

The U.S. Department of Agriculture identifies all shell eggs as natural.

Nest-Run Eggs

Eggs which are packed as they come from the production facilities without having been washed, sized, and candled for quality, with the exception that some checks, dirties, or other obvious undergrades may have been removed.

– *See Egg Products; Grading; Restricted Eggs*

Nutrient

Nutrients are chemical elements that are essential to plant and animal nutrition. While no one food (other than mother's milk, perhaps) provides all the nutrients a human needs, the egg contains a wide array of essential nutrients. After all, the egg was designed by nature to supply everything needed for the creation and nourishment of a baby chick.

All eggs contain the nutrients; protein and fat. Egg protein is of such high quality that it is often used as the standard by which other protein foods are measured. Egg protein contains all the essential amino acids (building blocks of protein which the body needs but cannot make) in a pattern that matches very closely the pattern the human body needs. This is why eggs are classified with meat in the Protein Food Group and why egg protein is called complete protein.

Nutrient Content of One Large Egg Raw, Fresh 1,2			
Nutrient	Whole Egg	Egg White	Egg Yolk
Energy (cal)	72	17	55
Protein (g)	6.3	3.6	2.7
Carbohydrate (g)	0.36	0.24	0.61
Total Fat (g)	4.8	0.06	4.5
Monounsaturated Fat (g)	1.8	0	2
Polyunsaturated Fat (g)	1	0	0.72
Saturated Fat (g)	1.6	0	1.6
Trans Fat (g)	0.02	0	0.02
Cholesterol (mg)	186	0	184
Choline (mg)	126	0.4	116
Riboflavin (mg)	0.2	0.15	0.09
Vitamin B12 (µg)	0.45	0.03	0.33
Folate (µg)	24	1	25
Vitamin D (IU)	41	0	37
Vitamin A (IU)	270	0	245
Vitamin B6 (mg)	0.09	0	0.06
Thiamin (mg)	0.02	0	0.03
Vitamin E (mg)	0.5	0	0.44
Selenium (µg)	15.4	6.6	9.5
Phosphorus (mg)	99	5	66
Iron (mg)	0.88	0.03	0.46
Zinc (mg)	0.65	0.01	0.39
Calcium (mg)	28	2	22
Sodium (mg)	71	55	8
Potassium (mg)	69	54	19
Magnesium (mg)	6	4	1

¹ U.S. Department of Agriculture, Agricultural Research Service, 2010. USDA National Nutrient Database for Standard Reference, Release 23. Nutrient Data Laboratory Home Page: <http://www.ars.usda.gov/nutrientdata>.

² Discrepancies between nutrients levels in the white+yolk vs. the whole egg are due to sampling error.

With the exception of vitamin C, an egg contains varying amounts of all the essential vitamins plus many minerals. An egg yolk is one of the few foods which naturally contain vitamin D, the sunshine vitamin.

Altogether, according to the USDA National Nutrient Database for Standard Reference, Release 23 (2010), a single large egg (50 grams) supplies 72 calories and contains the following nutrients: 6.3 grams of protein, 0.4 grams of carbohydrates, 4.8 grams of total fat.

As is true for most foods, cooking causes some minor nutrient losses in the egg. Of the nutrients in an egg, the vitamins riboflavin, thiamin and folic acid are generally less heat stable than other nutrients. You can preserve the highest nutrient content possible by proper cooking.

– See *Biological Value; Nutrient Density, Nutrition Education and Labeling Act, Protein*

Nutrient Density

The ratio of nutrients to calories that a food supplies when eaten. Foods that supply significant amounts of one or more nutrients compared to the number of calories they supply are called nutrient dense. Nutrientdense foods help you get important nutrients without excess calories.

Eggs have a high nutrient density because they provide a number of nutrients in proportion to their calorie count. One egg has 13 essential vitamins and minerals in varying amounts, high-quality protein, and antioxidants, all for 70 calories. Eggs are an excellent source of choline and selenium, and a good source of high quality protein, vitamin B12, phosphorus and riboflavin. The nutrients found in eggs can play a role in weight management, muscle strength, healthy pregnancy, brain function, eye health and more.
 – See *Biological Value, Calories, Choline, Daily Reference Value (DVRs), Nutrient, Protein*

Nutrient-Enhanced Eggs

Eggs created by varying the hens’ diets. Some shell eggs on the market have altered fat content. So, some eggs have reduced saturated fats and increased unsaturated fats. Other eggs are enriched with omega-3 fatty acids, the fats found in fish which are considered to be beneficial. Still other eggs have added vitamins, minerals or carotenoids. Check labels for nutrient facts. – See *Fat, Lutein, Omega-3 Fatty Acids*

It's All In An Egg! Thirteen Essential Vitamins and Minerals			
	Essentials	Facts	Daily Value
Excellent Source*	Choline	Essential for normal function of all cells, including those involved with metabolism, brain and nerve function, memory and the transportation of nutrients throughout the body. Choline also helps prevent birth defects, as well as helps promote brain and memory development in infants.	23%
	Selenium	Acts as an antioxidant to prevent the breakdown of body tissues. Selenium works hand-in-hand with vitamin E to protect against some chronic diseases.	
Good Source*	Riboflavin	Helps to produce energy in all the cells of the body.	22%
	Vitamin D	Works with calcium to strengthen bones and teeth.	
	Phosphorus	Essential for healthy bones, teeth and cell membranes. Phosphorus is also required for energy production in the body.	14%
			10%
	Vitamin B12	Works to support normal digestion and nerve cell function.	10%
Pantothenic Acid	Helps break down food and assists body cells in producing energy.		
	Folate	Promotes proper fetal development and red blood cell formation.	8%
	Iron	Plays an important role in red blood cell production and oxygen transport.	7%
	Vitamin A	Supports growth and maintains healthy skin, vision and immune function.	6%
	Vitamin B6	Keeps nerve transmission running smoothly and aids protein in immune function.	5%
	Zinc	Assists in maintaining immune function, as well as body tissue growth and repair.	5%
	Calcium	Helps build and maintain strong bones and teeth. This mineral also plays an important role in nerve function, muscle contraction and blood clotting.	5%
			4%

¹ U.S. Department of Agriculture Research Service, USDA Nutrient Data Laboratory. USDA National Nutrient Database for Standard Reference, Release 23 (2010). NDB No: 01123.

* Excellent Source and Good Source as defined by US Food and Drug Administration

Nutrient Labeling and Education Act (NLEA)

The 1990 Nutrition Labeling and Education Act (NLEA) requires most foods, including eggs, to carry a nutrition label. Current labels express nutrients as a percentage of Daily Values (DVs) for a 2,000-calorie diet, rather than a percentage of the U.S. Recommended Daily Allowances (U.S. RDAs). Eggs are produced by nature, not processed according to a formula, and may differ somewhat in nutrient content based on the individual hen and her diet, even within the same size. Based on assay figures and labeling rounding rules for nutrients, a label on a typical one-dozen carton of large eggs might read as follows:
 – See *Daily Reference Values (DRVs), Daily Values (DVs), U.S. Recommended Daily Allowance*

Oeufs à la neige

– See *Meringues – Poached Meringues*

Oiling

A thin film of odorless, tasteless mineral oil sprayed on eggs before cartoning. The oil replaces the natural bloom, the protective coating on the outside of the egg which is removed during washing. About 10% of eggs are oiled.

– See *Bloom, Cuticle*

Omega-3 Fatty Acids

The omega-3 fatty acids found naturally in fish and seafood are considered essential components of the diet because your body can't make them from the foods you eat. Shell eggs also contain some naturally occurring omega-3 fatty acids, on average about 30 mg per egg. Omega-3- enhanced eggs provide more, from 100 to over 600 mg per egg.

– See *Fat*

Omelet

Beaten eggs cooked in a pan and rolled or folded. The ancient Romans supposedly made the first omelet and, because it was sweetened with honey, they called it ovemele (eggs and honey). Some insist this was the origin of the word omelet. Others maintain the word was derived from amelette (Fr) meaning blade, describing the long, flat shape of an omelet.

Whatever its origin, an omelet can hold or be topped with any food from caviar to leftover meatloaf. The list of filling and topping possibilities is endless, limited only by your imagination and the contents of your refrigerator. Select, prepare and cook the filling ingredients before starting the eggs because omelets cook so quickly that you won't have time later

Omelets take different forms depending on how you cook them. The quickest and easiest form of omelet, the French or plain omelet, cooks in about a minute or two on top of the range. Conveniently, no stirring is required for a microwaved French omelet. For a puffy or soufflé omelet, separately beat the egg yolks and whites, cook on top of the range, then finish the omelet in the oven. However you prepare them, easy-to-make omelets don't require special pans or chef skills. Visit www.IncredibleEgg.org for omelet recipes.

– See *Frittata, Omelet Fillings, Tortilla*

Omelet Fillings

Almost any food can fill an omelet – vegetables or fruits; grains, including rice; lean meat, poultry, fish or seafood; yogurt or cheeses of all kinds. To invent your own omelet filling, use one or more filling ingredients to total about 1/3 to 1/2 cup for each omelet. Flavor the omelet, the filling or both with about 1/8 to 1/4 teaspoon of your favorite herb, spice or seasoning blend, or a dip, salad dressing or other flavoring mix.

Omelets cook very quickly, so heat refrigerator-cold fillings to serving temperature or fully cook raw foods before you begin cooking the eggs. Fill an omelet right after you've finished cooking it. At this point, the omelet will be hot enough to melt cheese and warm some filling ingredients, such as yogurt, peanut butter, jelly or sliced fruit.

Nutrition Facts			
Serving Size 1 egg (50g)			
Servings per Container 12			
Amount Per Serving			
Calories 70	Calories from Fat 45		
		% Daily Value *	
Total Fat 5g			8%
Saturated Fat 1.5g			8%
Trans Fat 0g			
Cholesterol 185mg			62%
Sodium 70mg			3%
Potassium 70mg			2%
Total Carbohydrate 0g			0%
Protein 6g			12%
Vitamin A 6% • Vitamin C 0%			
Calcium 2% • Iron 4%			
Vitamin D 10% • Thiamin 0%			
Riboflavin 15% • Vitamin B6 4%			
Folate 6% • Vitamin B12 8%			
Phosphorus 10% • Zinc 4%			
Not a significant source of dietary fiber and sugars.			
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:			
	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500mg	3,500mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g
Protein		50g	65g
Calories per gram:			
Fat 9 • Carbohydrate 4 • Protein 4			

Omelet King

Howard Helmer, holder of three Guinness World Records for omelet making – fastest omelet-maker (427 omelets in 30 minutes); fastest single omelet (42 seconds from whole egg to omelet); and omelet flipping (30 flips in 34 seconds).

Howard is known for spreading the good word of the good egg to consumers across the country through appearances on radio and television, newspaper and magazine articles and live cooking demonstrations .

Organic Eggs

Eggs produced according to national U.S. Department of Agriculture organic standards related to methods, practices and substances used in producing and handling crops, livestock and processed agricultural products.

All organic eggs are free-range eggs and must meet all of the requirements for those, including being raised outdoors or having access to the outdoors as weather permits.

Among other requirements, organic eggs are produced by hens fed rations having ingredients that were grown without most conventional pesticides, fungicides, herbicides or commercial fertilizers. While growth hormones are also prohibited, no commercial laying hen rations (whether organic or not) ever contain hormones. Due to higher production costs and lower volume per farm, organic eggs are more expensive than eggs from hens fed conventional feed. The nutrient content of eggs is not affected by whether or not the feed ration is organic.

– *See Production*

Ovary

The hen's reproductive organ in which egg yolks develop.

– *See Formation*

Oviduct

The organ in the hen which accepts the yolk after ovulation, where the egg is completed.

– *See Formation*

Oviposition

Laying of the hen's egg.

– *See Formation*

Ovulation

Release of the egg yolk from the hen's ovary.

– *See Formation*

Packaging

While the most familiar egg package is the pulp or foam carton holding one dozen eggs, eggs are now being packed in more different package sizes than ever before. In some regions, cartons or other packs of 6, 8, 12, 18, 30, 36 or 60 eggs are available, making it easy to buy eggs for households of almost any size. To maintain quality, buy only as many eggs as you will use within three to four weeks.

Whether made of pulp, foam or clear plastic, the carton insulates the eggs from jolts. New package designs are constantly being tested to provide the best protection for the eggs. The carton also prevents loss of moisture and carbon dioxide from the eggs and keeps the eggs from picking up undesirable odors and flavors. Because temperatures fluctuate more on the refrigerator door and slamming can cause breakage, it's best to store eggs in their carton on a middle or lower inside shelf.

Packing machines place eggs in their cartons large end up to keep the air cells in place and the yolks centered. The carton shows brand, grade, egg size and nutrient content.

Pain Perdu

– *See French Toast*

Partnership For Food Safety Education

Composed of government agencies, organizations such as American Egg Board, and other nonprofit groups, the Partnership works to educate consumers on the proper handling of foods to prevent foodborne illness.

www.befoodsafe.org

www.fightbac.org

www.befoodsafe.gov

The Be Food Safe and Fight Bac! programs of the Partnership are based on four simple steps:

Clean

Wash hands and surfaces often.

Separate

Don't cross-contaminate.

Cook

Cook to proper temperatures.

Chill

Refrigerate promptly.

– See *Cooking Methods, Doneness Guidelines, Egg Safety, Fight BAC!, Raw Eggs, Salmonella*

Pasteurized Eggs

Eggs that have been exposed to heat in order to destroy potential bacteria. Due to the heat process, pasteurized eggs may have slightly lower amounts of heat-sensitive vitamins, such as riboflavin, thiamin and folic acid.

Along with updating recipes to cook them properly -- using pasteurized egg products and shell eggs is an option for safely preparing recipes calling for raw or undercooked eggs. Although the rate of egg contamination with Salmonella bacteria is only about 1 in 20,000 eggs, it's best to choose one of these options when you make raw or only partially cooked recipes – especially when you serve the very young, the elderly, pregnant women or anyone whose immune system is impaired.

Pasteurized shell eggs are especially suitable for preparing egg recipes that aren't fully cooked, but you can also use them for other recipes, too, including baked goods. The heating process may create cloudiness in the whites and increase the time you need to beat the whites for foam formation. Allow up to about four times as much time for full foam formation to occur in pasteurized egg whites as you would for the whites of regular eggs. Prepare other recipes as usual.

Pasteurized shell eggs must be kept refrigerated. You can store them for at least 30 days from the pack date.

Pasture-Fed Hens

– See *Free-Range Eggs*

Pavlova

– See *Hard or Swiss Meringue*

Peeling

Removing the shell and membranes from a hard-boiled egg.

Opinion among researchers is divided as to whether or not salt in the cooking water helps make hard-boiled eggs easier to peel. Some research indicates that a 1 to 10% salt level (2 to 4 tablespoons per gallon of water) makes unoiled eggs easier to peel, but peelability of oiled eggs is not significantly affected. About 90% of the eggs available at retail are unoiled.

A nicely centered yolk makes very attractive deviled eggs and garnishes. However, as an egg ages, the white thins out which gives the yolk more opportunity to move about freely. This can result in a displaced yolk when you cook the egg. Using the freshest eggs possible will minimize this displacement, but very fresh eggs are more difficult to peel after hard boiling. The air cell that forms between the shell membranes as the egg ages helps to separate shell from egg but, in very fresh eggs, the air cell is still small. The best compromise for attractive eggs with centered yolks that are relatively easy to peel seems to be using eggs that have been

refrigerated for about a week to 10 days. Some new research suggests that yolk centering may be better if you store eggs small-end up for 24 hours before hard-boiling.

Immediately after cooking, thoroughly cool eggs in a bowl of ice or under running cold water; five minutes isn't too long. Peel the eggs right after cooling for immediate use or refrigerate them in the shell in the carton for use within one week. To peel an egg, crackle the shell all over by gently tapping the egg on a table or countertop. Roll the egg between your hands to loosen the shell. Then peel off the shell, starting at the large end. Hold the egg under running water or dip it in water to make peeling easier.

– See *Air Cell; Composition; Cooking Equipment, Piercer; Cooking Methods, Hard-Boiled*

Pet Food

Eggs are often an important part of prepared pet-food formulas. Some pet owners also feed eggs to their pets as treats or prepare homecooked pet food using eggs.

Pickled Eggs

Hard-boiled eggs marinated in vinegar and pickling spices, spicy cider, or juice from pickles or pickled beets.

Unopened containers of commercially pickled eggs keep for several months on the shelf (see specific product for details). After opening, keep refrigerated and use within seven days. Home-prepared pickled eggs must be kept refrigerated and used within seven days. Home canning of pickled eggs is not recommended. Although the acidity of the pickling solution is usually sufficient to prevent the growth of bacteria, it eventually causes the eggs to disintegrate.

– See *Cooking Methods, Hard-Boiled; Peeling*

Poached Eggs

– See *Cooking Methods, Poached*

Popovers

An egg-rich, hollow bread baked in small cups or pans. A very hot oven creates the steam inside the batter that pops the individual breads to magnificent heights.

Pot de Crème

– See *Custard-Baked*

Preservation

Refrigeration, drying or freezing are the best ways to preserve egg quality. Fresh eggs are so readily available that long storage periods are rarely necessary. However, centuries before modern methods of egg production, transportation and refrigeration became known, people did their ingenious best to preserve the egg intact.

The ancient Chinese stored eggs up to several years by immersion in a variety of such imaginative mixtures as salt and wet clay; cooked rice, salt and lime; or salt and wood ashes mixed with a tea infusion. Although the Chinese ate them with no ill effects of which we are aware, the eggs thus treated bore little similarity to fresh eggs, some exhibiting greenish-gray yolks and albumen resembling brown jelly.

Immersion in different liquids too numerous to mention was explored, lime water being a favorite in the 18th century. During the early 20th century, water glass was used with considerable success. Water glass, a bacteria-resistant solution of sodium silicate, discouraged the entrance of spoilage organisms and evaporation of water from eggs. It didn't penetrate the eggshell, imparted no odor or taste to the eggs and was considered to have somewhat antiseptic properties. However, it did a rather poor job at relatively high storage temperatures. Eggs preserved in a water-glass solution and stored in a cool place keep 8 to 9 months.

Dry packing in various substances ranging from bran to wood ashes was used occasionally, but costs of transporting the excess weight of the packing material far exceeded the dubious advantages.

In an attempt to seal the shell pores to prevent loss of moisture and carbon dioxide, a great variety of materials including cactus juice, soap and shellac were investigated with varying degrees of success. The only coating considered fairly efficient was oil, which still is used occasionally today. Thermostabilization, immersion of the egg for a short time in boiling water to coagulate a thin film of albumen immediately beneath the shell membrane, was rather extensively practiced by housewives of the late 19th century. Mild heating

destroyed spoilage organisms but didn't cook the eggs. If kept in a cool place, thermostabilized eggs coated with oil keep several months, although some mold growth may take place.

During the first half of the 20th century, storing eggs in refrigerated warehouses was a common practice. Preservation was later improved with the introduction of carbon dioxide into the cold storage atmosphere. Today, very few, if any, cold storage eggs find their way to the retail market.

– See *Cold Storage, Oiling*

Price Per Pound

An easy way to compare the price of eggs with other protein foods.

– See *Buying*

Profiteroles

–See *Cream Puffs*

Production

Egg Production during the year ending November 30, 2011 totaled 91.9 billion eggs, up slightly from 2010. Table egg production, at 79.0 billion eggs, was up 1 percent from the previous year.

Breeds

Maximum production of top-quality eggs starts with a closely controlled breeding program emphasizing favorable genetic factors. The Single-Comb White Leghorn hen dominates today's egg industry. This breed reaches maturity early, utilizes its feed efficiently, has a relatively small body size, adapts well to different climates and produces a relatively large number of whiteshelled eggs, the color preferred by most consumers. Brown-shelled eggs are now available in most markets, but have long been the traditional favorite in the New England region. Commercial brown-egg layers are hens derived from the Rhode Island Red, New Hampshire and Plymouth Rock breeds which predominated in that area of the country.

– See *Color, shell*

Resistance to Disease

Selective breeding is reinforced by good sanitation and vaccination.

Environment

Light Control

Of primary importance during both the growing and laying periods, controlled, low-intensity light can be used in house systems to delay sexual maturity until the bird's body is big enough to produce larger eggs. Intensity and duration of light can be adjusted to regulate production.

Temperature

Laying houses maintained between 57° and 79°F (14° and 26°C) are desirable.

Humidity

A relative humidity between 40 and 60% is optimal.

Housing Systems

America's egg farmers are committed to producing a fresh, high-quality product and therefore are committed to the health and well-being of their hens. Housing systems today vary, but all ensure the hens are provided with adequate space, nutritious feed, clean water, light and fresh air. America's egg farmers produce eggs from multiple production systems – conventional, cage-free, free-range, and enriched colony. All organic systems are free-range.

Conventional: Eggs laid by hens living in cages with access to feed, water, and security. The cages serve as nesting space as well as for production efficiency. In this type of hen house, the birds are more readily protected from the elements, from disease and from natural and unnatural predators.

Cage-free: Eggs laid by hens at indoor floor operations, sometimes called free-roaming. The hens may roam in a building, room or open area, usually in a barn or poultry house, and have unlimited access to fresh food and

water, while some may also forage for food if they are allowed outdoors. Cage-free systems vary and include barn-raised and free-range hens, both of which have shelter that helps protect against predators. Both types are produced under common handling and care practices, which provide floor space, nest space and perches. Depending on the farm, these housing systems may or may not have an automated egg collection system.

Free-range: Eggs produced by hens that have access to outdoors in accordance with weather, environmental or state laws. In addition to consuming a diet of grains, these hens may forage for wild plants and insects and are sometimes called pasture-fed hens. They are provided floor space, nesting space and perches.

Organic: Eggs produced according to national U.S. Department of Agriculture organic standards related to methods, practices and substances used in producing and handling crops, livestock and processed agricultural products. Organic eggs are produced by hens fed rations having ingredients that were grown without most conventional pesticides, fungicides, herbicides or commercial fertilizers.

Enriched Colony: A production system that contains adequate environmental enrichments to provide perch space, dust bathing or a scratch area(s), and nest space to allow the layers to exhibit inherent behavior. Enriched colony systems are American Humane Certified.

Feed

Since more is known about the nutritional requirements of the chicken than of any other domestic animal, feed rations are scientifically balanced to assure layer health along with optimum quality eggs at least cost. Automatic feeders, activated by a time clock, move feed through troughs that allow for feeding ad libitum. Birds are also provided water at all times via nipple valves separate from the feed troughs.

Poultry rations are designed to contain all the protein, energy (carbohydrates), vitamins, minerals, and other nutrients required for proper growth egg production, and health of the layer hen. Feed might be based on sorghum, grains, corn, cottonseed meal or soybean meal, depending on the part of the country in which the ration is produced and which ingredient is most available and cost effective. The hen's ration may contain the same types of additives approved for human food. Antioxidants or mold inhibitors (also used in mayonnaise and bread) are added to maintain the quality of the feed. An additive is not approved for use in poultry feed unless adequate research has been undertaken to determine its pharmacological properties and possible toxicity and to discover any potentially harmful effects on animals.

Federal regulations prohibit the feeding of hormones to any kind of poultry in the U.S. Antibiotics are only rarely used when chickens are ill, at which time they seldom lay eggs. If antibiotics are used, FDA regulations require a withdrawal period for laying hens to ensure eggs are free of antibiotics.

How much a layer eats depends upon the stage of life, the hen's size, the rate of egg production, temperature in the laying house and the energy level of the feed. In general, about 4 pounds of feed are required to produce a dozen eggs. A Leghorn chicken eats about 1/4 pound of feed per day. Layers of brown-shelled eggs are slightly larger and require more feed. The type of feed affects egg quality. Shell strength, for example, is determined by the presence and amounts of vitamin D, calcium and other minerals in the feed. Too little vitamin A can result in blood spots. Yolk color is influenced by yellow-orange plant pigments in the feed. Maximum egg size requires an adequate amount of protein and essential fatty acids.

Flock Management

Molting, or loss of feathers, is a natural occurrence common to all birds regardless of species. In the wild, egg quality declines as the hen ages and, at about 18 to 20 months of age, molting occurs and egg production ceases. In conventional egg production, a fairly common practice is to place the flock into a controlled molt. A low-protein diet minimizes stress on the birds as they go through this transition period. After a rest period of 4 to 8 weeks, the birds start producing eggs again. Researchers have found that two periods of controlled molting, one at 14 months and another at 22 months, increases egg production more than one molt at 18 or 20 months, though few egg farmers place flocks into two controlled molts. Controlled molting is not permitted in organic flocks, though natural mottling can occur.

Egg Handling

In most commercial egg production facilities, automated belts gather eggs every day. Gathered eggs are moved into refrigerated holding rooms where temperatures are maintained between 40° and 45°F (4° and 7°C).

– See *Cleaning*

Egg Processing and Distribution

Some producers sell their eggs nest-run (ungraded) to processing firms which clean, grade, size and carton the eggs and ship them off to retail outlets. Most farms and ranches carry out the entire operation.

– See *Egg Products, Egg Products Inspection Act, Grading, Nest-Run Eggs*

Protein

A combination of amino acids, some of which are called essential, meaning the human body needs them from the diet because it can't synthesize them. Adequate dietary protein intake must include all the essential amino acids your body needs daily. The egg boasts them all: histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. These amino acids are present in a pattern that matches very closely the pattern the human body needs, so the egg is often the measuring stick by which other protein foods are measured. In addition to the nine essential amino acids, there are nine other amino acids in an egg.

Many different ways to measure protein quality have been developed. According to the Protein Digestibility Corrected Amino Acid Score (PDCAAS), whole egg, whey protein, casein and soy-protein concentrate all score 1 on a scale of 0 to 1. Whole egg exceeds all other protein foods tested with a score of 1.21 (above human needs) in the Amino Acid Score (AAS) rating system. At 3.8, the Protein Efficiency Ratio (PER) of eggs also outscores other proteins. When Nitrogen Protein Utilization (NPU) is evaluated, whole egg at 98% falls just below whey protein and casein (both at 99%). On a scale with 100 representing top efficiency, the Biological Value (BV) of eggs is rated between 88 and 100, with only whey protein rated higher (100).

Altogether each large egg provides a total of 6.29 grams of high-quality, complete protein. For this reason, eggs are classified with meat in the Protein Foods Group. One egg of any size equals one ounce of lean meat, poultry, fish or seafood. In addition to about 12.6% of the Daily Reference Value (DRV) for protein, a large egg provides varying amounts of many other nutrients, too.

– See *Biological Value, Buying, Daily Reference Values (DRVs), Food Guide Pyramid, Meat Replacement, Nutrient, Density*

Pullet

A young female chicken less than 1 year old. For egg layers, a pullet is a young female before she reaches sexual maturity and starts laying eggs, around 17-18 weeks.

Quiche

An unsweetened, open-faced custard pie, served hot or cold as a main dish, appetizer or snack. A quiche requires only a few ingredients: eggs, milk, seasonings and whatever else you might want to add in the way of flavoring, such as shredded cheese or chopped cooked vegetables, meat, poultry, fish or seafood. You can make a familysized quiche in a regular pie plate or in a quiche dish. Custard cups make handy holders for individual quiches. A traditional quiche is made in a pastry crust. For less fat, you can also make a crust out of cooked rice or cereal, bread or cracker crumbs, mashed beans or potatoes, or chopped spinach. You can line custard cups with bread for toast cups or use won ton wrappers or tortillas in place of pastry. Visit www.IncredibleEgg.org for quiche recipes.

– See *Cooking Equipment, Custard Cups, Quiche Dish*

Quiche Lorraine

A classic quiche flavored with bacon and Swiss cheese. Frenchmen claim that this savory custard pie originated in the province of Lorraine, but Germans insist it's a creation from Alsace.

Raw Eggs

Since raw eggs may contain the bacteria *Salmonella enteritidis*, it's recommended that you don't consume raw or undercooked eggs. *Salmonella* may be found inside the egg, most likely in the white, so it's necessary to properly cook all eggs and egg dishes before eating. For safety, many recipes that contain raw or undercooked eggs can be revised with a cooking step. Pasteurized shell eggs or pasteurized egg products are also safe alternatives to use in these recipes.

– See *Cooking Methods, Doneness Guidelines, Products, Egg Safety, Fight BAC!, Partnership for Food Safety Education, Pasteurized Eggs, Salmonella*

Recommended Daily Allowances

A term used to denote nutrient recommendations for 26 nutrients for 18 different population subgroups. RDAs are based on information on nutrient allowances for healthy people from the National Research Council of the National Academy of Sciences. In 2005, a broader set of dietary reference values, known as the Dietary Reference Intakes (DRIs) replaced the RDA and RNIs intended to help individuals optimize their health and prevent disease. This information is revised about every five years and is used to determine the Daily Value and Reference Daily Intake figures used on food labels.

Reference Daily Intakes

A term that replaced the U.S. Recommended Daily Allowances (U.S. RDAs). RDIs are based on a population-weighted average of the latest RDAs for vitamins and minerals for healthy Americans over 4 years old. RDIs are not recommended daily intake figures for any particular age group or sex. They are simply average values for the entire U.S. population. For vitamins and minerals, RDIs are: – See Daily Reference Values (DRVs), Daily Values (DVs), Recommended Dietary Allowances (RDAs), U.S. Recommended Daily Allowances (U.S. RDAs)

Vitamin and Mineral Reference Daily Intakes (RDIs)			
Vitamins		Minerals	
A*	5000 IU	Calcium*	1000 mg
C*	60 mg	Iron*	18 mg
D	400 IU	Phosphorus	1000 mg
E	30 IU	Iodine	150 mcg
K	80 mcg	Magnesium	400 mg
Thiamin (B1)	1.5 mg	Zinc	15 mg
Riboflavin (B2)	1.7 mg	Selenium	70 mcg
Niacin	20 mg	Copper	2 mg
B6	2 mg	Manganese	2 mg
Folate	400 mcg	Chromium	120 mcg
B12	6 mcg	Molybdenum	75 mcg
Biotin	300 mcg	Chloride	3400 mg
Pantothenic Acid	10 mg		

Remoulade

Classic French mayonnaise-based sauce with mustard, capers, chopped gherkin pickles, herbs and anchovies.
– See *Mayonnaise*

Restricted Eggs

Ungraded eggs, specifically checks, dirties, incubator rejects, inedibles, leakers and loss eggs.

Checks have a broken shell or a crack in the shell, but the shell membranes are intact so that the egg contents don't leak.

Dirties may have adhering dirt, prominent or conspicuous stains, or moderate stains covering more than one-fourth of the shell surface.

Incubator rejects have been subjected to the incubation process for a period of time. Inedibles are moldy, musty or sour or exhibit rot, blood rings, green whites, stuck yolks or embryo chicks.

Leakers have a crack or break in both shell and shell membranes so that the contents are leaking.

Loss eggs are leakers, inedibles and any eggs that have been cooked, frozen or contaminated.

The Egg Products Inspection Act (EPIA) controls the disposition of restricted eggs to prevent them from getting into consumer channels.

Checks and dirties may be sent to U.S. Department of Agriculture (USDA) -inspected egg-products plants where they can be handled and processed properly. They can't be sold in the shell to restaurants, bakeries, food manufacturers or consumers unless such sales are specifically exempted by section 15 of the Act and not prohibited by state law. All other restricted eggs must be disposed of according to approved procedures.

Roasted Egg

An egg which appears on the Jewish Passover plate as part of the ritual. The egg is hard-boiled, then roasted in the oven until the shell becomes brown.

Listing the percentage of RDI for this nutrient is mandatory on food labels. Listing the percentage of RDI for other nutrients on food labels is optional. Source: <http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/FoodLabelingGuide/ucm064928.htm#T3SOqywnUM4.email>

Sabayon Sauce

– See *Zabaglione*

Salmonella

One of several types of bacteria which can cause foodborne illness (salmonellosis) if ingested in large numbers. The Salmonella group of bacteria can be found in the intestinal tract of animals, birds, insects, reptiles, fish, seafood and people. Salmonella can be passed to humans through the consumption of contaminated foods that have been in contact with unwashed hands, raw meat or poultry, eggs, seafood, milk, or by coming in contact with contaminated animal feces. It was once thought that inside of the chicken egg was sterile, the shell protecting the contents from any kind of contamination. Dr. St. Louis and colleagues discovered in the late 1980's that a bacteria, Salmonella Enteritidis, could indeed get inside the egg through the hens reproductive tract. Since this discovery, researchers, egg producers, and government agencies have worked hard to implement and maintain practices to ensure that the hen does not have the ability to shed SE into the egg. The chance of an egg becoming infected with SE is very low. If it is present in the egg, producers can control the growth through refrigeration and kill it with processes like pasteurization. SE will not grow at temperatures below 40°F (4°C) and is killed at 160°F (71°C). Temperatures between 40°F (4°C) and 140°F (60°C), known as the danger zone, are ideal for rapid growth. Eggs are required to be refrigerated at or below 45°F (7°C) no later than 36 hours after being laid.

The majority of salmonellosis outbreaks have been attributed to foods other than eggs – nuts, vegetables, chickens, beef and fish – and through cross contamination of utensils and other foods used during preparation. Of the outbreaks involving eggs, most have occurred in foodservice operations and have been the result of inadequate refrigeration and insufficient cooking. You can avoid illness from SE through adequate refrigeration, proper cooking and sanitary kitchen and food handling procedures.

– See *Buying, Cooking Methods, Doneness Guidelines, Egg Safety, Fight BAC!, Partnership for Food Safety Education, Raw Eggs, Storing*

Saturated Fat

– See *Fat*

Sauces

In addition to the primary function of thickening sauces, eggs enrich flavor, add color and increase nutritive value.

You can use a milk or cream sauce thickened with eggs to bind casseroles and meatloaves or serve a sweetened egg-thickened sauce with a dessert.

Butter sauces are emulsions of butter and other liquids. When heated, the egg both thickens and strengthens the emulsion. Hollandaise is the best known sauce of this type.

Other egg sauces include those in which chopped hard-boiled eggs are an ingredient.

– See *Custard, Stirred; Hollandaise Sauce*

Schaum Torte

– See *Hard or Swiss Meringue*

Scotch Eggs

Hard-boiled eggs coated with sausage, breaded and deep-fried.

Scrambled Eggs

– See *Cooking Methods, Scrambled*

Serving Sizes

A serving of an individual food is defined by U.S. Department of Agriculture (USDA) for dietary guidance and by FDA for food labels. One egg equals one serving.

– See *My Plate*

Shell

The egg's outer covering, accounting for about 9 to 12% of its total weight, depending on the egg size. The shell is the egg's first line of defense against bacterial contamination.

The shell is largely composed of calcium carbonate (about 94%) with small amounts of magnesium carbonate, calcium phosphate and other organic matter, including protein.

Shell strength is greatly influenced by the minerals and vitamins in the hen's diet, particularly calcium, phosphorus, manganese and vitamin D. If the diet is deficient in calcium, for instance, the hen will produce a thin or softshelled egg or possibly an egg with no shell. Occasionally an egg may be prematurely expelled from the uterus due to injury or excitement. In this case, the shell has not had time to be completely formed. Shell thickness is also related to egg size which, in turn, is related to the hen's age. As the hen ages, egg size increases. The same amount of shell material which covers a smaller egg must be stretched to cover a larger one, hence the shell is thinner.

Seven to 17 thousand tiny pores are distributed over the shell surface, a greater number at the large end. As the egg ages, these tiny holes permit moisture and carbon dioxide to move out and air to move in to form the air cell. The shell is covered with a protective coating called the cuticle or bloom. By blocking the pores, the cuticle helps to preserve freshness and prevent microbial contamination of the contents. Egg shell uses vary from the thrifty, such as compost, to the creative, as in decorated eggs.

– See Air Cell; Bloom; Color, Shell; Composition; Decorating Eggs; Formation; Oiling

Shirred Eggs

– See *Cooking Methods-Baked*

Size

Several factors influence the size of an egg. The major factor is the age of the hen. As the hen ages, her eggs increase in size. The breed of hen from which the egg comes is a second factor. Weight of the bird is another. Pullets significantly underweight at sexual maturity will produce small eggs. Environmental factors that lower egg weights are heat, stress, overcrowding and poor nutrition. All of these variables are of great importance to the egg producer. Even a slight shift in egg weight influences size classification and size is one of the factors considered when eggs are priced. Careful flock management benefits both the hens and the producer.

– See *Buying, Grading, Production, Treatment of Hens*

Size Equivalent

Although you can use any size egg for frying, scrambling, hard-boiling or poaching, most recipes for baked items such as custards and cakes are based on the use of large eggs.

– See *Buying*

Egg Size Substitution				
Large	Jumbo	X-Large	Medium	Small
1	1	1	1	1
2	2	2	2	3
3	2	3	3	4
4	3	4	5	5
5	4	4	6	7
6	5	5	7	8

Source: American Egg Board

Number of eggs equivalent to 1 cup.			
Egg Size	Whole	Whites	Yolks
Jumbo	4	5	11
X-Large	4	6	12
Large	5	7	14
Medium	5	8	16
Small	6	9	18

Source: American Egg Board

Snow Eggs

– See *Meringue-Poached Meringues*

Soufflé

A puffy, delicate, light-as-air creation. Savory or sweet, hot or cold, soufflés are sensational and impressive whether served as a main dish, accompaniment or dessert.

Strictly speaking, a true soufflé consists of a thick white sauce blended with beaten egg yolks and leavened by stiffly beaten whites. It may also contain pureéd, shredded or finely chopped meat, poultry, fish, seafood, cheese or vegetables, and is always served hot. You can substitute a condensed cream soup or quick-cooking tapioca cooked in milk for the white sauce. For sweet or dessert soufflés, you can add sugar to the sauce.

Like many skills, making a successful soufflé is easy when you know how. A mastery of the following basics will have you turning out soufflés with the best of them.

If you don't have a traditional soufflé dish, use a straight-sided casserole dish or even a straight-sided uncoated saucepan of the proper size. For individual servings, you can use large custard cups or ovenproof coffee or soup mugs. As it bakes, the soufflé will increase in volume 2 to 3 times, so container size is important. If the container is too large, the mixture will not rise above the rim and have the lofty look that is part of a soufflé's charm. If the container is too small, the mixture may run over. Usually a 4-egg soufflé will fit a 1 1/2- to 2-quart container. Use a 2- to 2 1/2-quart container for a 6-egg soufflé. You can fill the container to within 1/2-inch of the top.

A soufflé needs to cling to the sides of the container to reach its maximum height. So, don't butter the container unless you also lightly dust the buttered bottom and sides of the container with grated Parmesan cheese, cornmeal or very fine, dry bread crumbs, which will lend flavor and a nice crusty texture. For dessert soufflés, you can dust with sugar, finely chopped nuts or cookie crumbs, if you like.

If your container is a tad too small or your beating and folding skills are exceptional, you can fit a collar around the top of the container to keep the soufflé in bounds. Make a 4-inch band of triple-thickness aluminum foil long enough to go around the container and overlap 2 inches. Butter and dust the band. Wrap the band around the outside of the dish with the dusted side in and fasten it with strong masking tape or string. The collar should extend at least 2 inches above the rim of the container.

– See *Cooking Terms*, *add cream of tartar*, *gently folded*, *separated*, *stiff but not dry*

Soufflé, Cold

A term loosely applied to a number of airy egg dishes with a texture closely resembling a soufflé. For the purist, however, cold soufflés are more accurately known as snows or sponges, chiffons or Bavarians. Snows or sponges are clear gels plus egg whites. To make one, you add unbeaten egg whites to a partially-set basic gelatin mixture and beat until soft peaks form. Then chill until firm. Chiffons consist of beaten egg whites added to custard gels. For the custard base, you cook egg yolks with gelatin. Then fold in stiffly beaten egg whites and chill the mixture. You can enjoy a chiffon as is or use it for a pie filling. Bavarians are custard gels you make with egg yolks, then add both beaten egg whites and whipped cream. These recipes are usually made with raw whites and/or yolks, but some can be cooked. – See *Doneness Guidelines*, *Cooking Yolks and Whites for Recipes*, *Egg Safety*, *Partnership for Food Safety Education*, *Raw Eggs*, *Salmonella*

Sponge Cake

An airy foam cake similar to angel food cake, except that sponge cake may be made with egg yolks or with whole eggs. True sponge cakes contain no fat or leavening agent other than eggs.

– See *Angel Food Cake*, *Foams*

Storing

The refrigerator is where you should store your eggs. It's best to place the eggs on an inside shelf. Repeated opening and closing of the door causes temperature fluctuations and slamming can result in breakage. The carton in which you purchase them helps keep the eggs from picking up odors and flavors from other foods and helps prevent moisture loss.

You can keep fresh, uncooked eggs in the shell refrigerated in their cartons for at least four to five weeks beyond the pack date or about three weeks after you bring them home. Properly handled and stored, eggs rarely spoil. If you keep them long enough, they are more likely to simply dry up. But don't leave eggs out. They'll age more in one day at room temperature than they will in one week in the refrigerator.

As soon as you've cooled them, refrigerate hard-boiled eggs in their shells and use them within one week. When storing hard-boiled eggs, you may notice a gassy odor in your refrigerator. It may be more noticeable when you open the refrigerator infrequently. The odor is caused by hydrogen sulfide, which forms when the eggs are cooked, is harmless and usually dissipates within a few hours.

Egg Storage Chart

Product	Refrigerator	Freezer
Raw eggs in shell	3 to 5 weeks	Do not freeze.
Raw egg whites	Up to 4 days	12 months
Raw egg yolks	Up to 4 days	Yolks alone do not freeze well. – See Freezing Eggs
Hard-boiled eggs	1 week	Do not freeze.
Egg substitutes, liquid		
Unopened	10 days	Do not freeze.
Opened	3 days	Do not freeze.
Egg substitutes, frozen		
Unopened	After thawing, 7 days, or refer	12 months
Opened	to “Use-By” date on carton. After thawing, 3 days, or refer to “Use-By” date on carton.	Do not freeze.
Casseroles made with eggs	3 to 4 days	After baking, 2 to 3 months.
Eggnog, commercial	3 to 5 days	6 months
Eggnog, homemade	2 to 4 days	Do not freeze.
Pies, pumpkin or pecan	3 to 4 days	After baking, 1 to 2 months.
Pies, custard and chiffon	3 to 4 days	Do not freeze.
Quiche with any kind of filing	3 to 4 days	After baking, 1 to 2 months.

Source: U.S. Department of Agriculture (USDA)

For outdoor eating occasions, you can keep eggs refrigerator-cold with ice or commercial coolant in an insulated bag or picnic cooler as long as the ice lasts or the coolant remains almost at freezing. Unless it’s quite cold weather, for hiking, backpacking, camping and boating, when refrigeration or cooler facilities aren’t available, use dried eggs which are usually available in sporting goods stores. You can reconstitute dried eggs with purified water and use them in most of the ways you would use fresh eggs. Pickling and other forms of preservation are additional possibilities.

Refrigerate leftover egg whites in a covered container for up to four days. Store leftover yolks in water in a covered container in the refrigerator and use them in a day or two. If you can’t use the yolks quickly enough, hard boil them. If you find yourself with more eggs than you will use in several weeks, freeze them.

– See *Egg Products, Freezing, Leftover Egg Parts, Pickled Eggs, Preservation*

Strata

A custard mixture poured over layers of bread, cheese and sometimes additional ingredients, and baked. The strata casserole was created to use up stale bread.

Stuffed Eggs

– See *Deviled Eggs*

Syneresis

– See *Curdling*

Tartar Sauce

A mayonnaise-based sauce with chopped pickles, onion, traditionally served with fried fish.

Tempering

The technique used to blend uncooked eggs into hot mixtures. To temper, beat eggs and stir in a little of the hot mixture to warm (temper) the eggs. Then stir the warmed eggs into the remaining hot mixture. Tempering helps to prevent the eggs from curdling.

– See *Curdling*

Thickener

– See *Cooking Functions, Sauces*

Thousand Island Dressing

A mayonnaise-based with chili sauce, chopped pickles, onions, hard-boiled egg, green olives, green pepper.

– See *Mayonnaise*

Thousand-Year-Old Eggs

– See *Preservation*

Tortilla

Spanish term for a frittata.

– See *Frittata*

Treatment of Hens

Laying hens represent an egg producer's living and are treated with care. Like humans, hens seem to be more productive when they're healthy. In 1945, the average hen laid 151 eggs per year. Now as a result of breeding and better nutrition, housing and general management of facilities, the average hen lays between 250 and 300 eggs per year. America's egg farmers believe in consumer choice. Hens are raised and lay their eggs in a multitude of housi

ng systems subject to consumer's demand. No matter the system used, farmers are committed to the health and well-being of their hens. Without deference to the manner in which the eggs are produced, America's egg farmers follow guidelines to ensure the hens are provided with adequate space, nutritious feed, clean water, light, and fresh air.

The farming practices range from cage systems, cage-free, free-range, to organic systems. Proper lighting, housing, and diets are critical to the production process to ensure highquality egg production. Scientifically balanced feed insures that the birds are protected from improper or inadequate diets – a vast improvement over the days when hens foraged for food in barnyards or ate household scraps.

Chickens, like some other animals, may exhibit cannibalistic tendencies. To protect the birds from each other, part of their upper beaks or both lower and upper beaks are trimmed. The trimming process is done by a special machine which cauterizes the beak and may be compared to clipping a dog's claws. The birds are still able to eat and drink.

– See *Beak Trimming, Production*

Unsaturated Fat

– See *Fat*

Uses, Other

Beyond the culinary assets of eggs, numerous individual egg properties benefit mankind and other animals throughout a wide range of technologies:

Cosmetics

Egg white has long been used as a facial. Egg yolks are used in shampoos and conditioners and, sometimes, soaps. Cholesterol, lecithin and some of the egg's fatty acids are used in skin care products, such as revitalizers, make-up foundations and even lipstick.

Animal Feed

The excellent nutrition of eggs enhances various pet foods. Egg white is used as a protein reference in feeding laboratory animals. Eggshells from processing plants are often dried, crushed and fed to laying hens as a rich calcium source and high-quality protein source (from egg white left inside the shells).

Experiments

Microorganisms bred in laboratories often grow better if a small amount of egg yolk is added to the culture medium.

Medical and Pharmaceutical

Fertile eggs are used to manufacture many vaccines (including influenza shots), as a source of purified protein and as an aid in the preservation of bull semen for artificial insemination.

Nutraceutical

In some areas of the world, such as China, India and Eastern Europe, eggs have been used for centuries as the base for health potions. Today a number of nutraceutical uses of eggs are being employed and scientists are studying potential future egg benefits. Current applications include:

Lysozyme, an egg white protein, is used as a food preservative and as an antimicrobial agent in pharmaceutical products. (Nature also provides lysozyme in human tears and saliva for infection prevention.)

Avidin is an egg white protein and biotin is a vitamin found in egg white and, to a much greater extent, in egg yolk. Avidin-biotin technology is being used in various medical diagnostic applications such as immunoassay, histopathology and gene probes.

Sialic acid, an amino acid, has been shown to inhibit certain stomach infections.

Liposomes, fatty droplets found in eggs, are used as a controlled delivery mechanism for various drugs.

Immunoglobulin yolk (IGY), a simple egg-yolk protein which has immunological properties, is used as an anti-human-rotavirus (HRV) antibody in food products.

Phosvitin, a phosphoprotein found in egg yolk, provides antioxidant benefits in food products.

Choline, a B vitamin combined with lecithin in egg yolk, is important in brain development and is used to treat certain liver disorders. Eggs are one of the best food sources of choline.

Ovolecithin, a phospholipid found in egg yolk, has a high proportion of phosphatidylcholine and contains fatty acids – such as arachidonic acid (AA) and docosahexanoic acid (DHA) – which have been shown to improve visual activity in infants and to improve fatty-acid status. Egg lecithin has both emulsifying and antioxidant properties and, beyond its usefulness in keeping the oil and vinegar of mayonnaise in suspension, it's used chiefly in medicine.

Shell-membrane protein is being used experimentally to grow human skin fibroblasts (connective tissue cells) for severe-burn victims and, in Japan, is being used in cosmetics.

U.S. Recommended Daily Allowances

A term that once indicated suggested intake levels for nutrients. U.S. RDAs simplified the RDAs of the National Academy of Sciences by providing a single recommended allowance for the general healthy population. With few exceptions, these allowances were based on the highest RDA for each nutrient – the amounts required for young adult males. Since these values were excessively high for children, women and the elderly, U.S. RDAs have been replaced by RDIs which represent average RDAs.

– See *Daily Reference Values (DRVs)*, *Daily Values (DVs)*, *Recommended Dietary Allowances (RDAs)*, *Reference Daily Intakes (RDIs)*

Vegetarian Diets

Eggs can be an important source of complete protein in diets that omit meats. One egg equals one ounce of lean meat, poultry, fish or seafood. Since an egg contains all the essential amino acids in proportion to human needs in addition to vitamin B12, a nutrient not found in vegetarian sources, adding an egg to a vegetarian diet can improve the healthfulness of a vegetarian diet.

– See *Nutrient, Protein, Reference Daily Intakes (RDIs)*

Vegetarian Eggs

Eggs produced by hens fed rations containing only vegetable foods.

Vitamins

An egg contains varying amounts of essential vitamins but no vitamin C.
– See *Biological Value, Nutrient, Reference Daily Intakes (RDIs)*

Vitelline Membranes

– See *Composition, Membranes*

Washing Eggs

– See *Cleaning*

Water Bath

Also known as a bain-marie. Some delicate dishes, such as custard, are cooked in the oven in a water bath. Before baking, place the baking dish or pan holding the custard in a larger baking pan and add very hot water to within 1/2 inch of the top of the custard. The water insulates the custard from too much heat and promotes even cooking.

– See *Custard, Baked*

Water Glass

A solution of sodium silicate formerly used to preserve eggs.
– See *Preservation*

Weeping

– See *Curdling; Meringue, Soft Meringue*

Weight

– See *Buying; Grading; Size*

Well Beaten

– See *Cooking Terms, Well Beaten*

White

– See *Albumen; Color, White; Composition; Foam*

Xanthophylls

– See *Lutein, Color-Yolk*

Yolk

The yolk, or yellow portion, of an egg makes up about 34% of the liquid weight of the egg. It contains all of the fat in the egg and a little less than half of the protein. The yolk of a large egg contains about 55 calories.

With the exception of niacin and riboflavin, the yolk contains a higher proportion of the egg's vitamins than the white, including vitamins B6 and B12, folic acid, pantothenic acid and thiamin. All of the egg's vitamins A, D, E and K are in the yolk. Egg yolks are one of the few foods naturally containing vitamin D. The yolk also contains more calcium, copper, iron, manganese, phosphorus, selenium and zinc than the white.

Double-yolked eggs are often produced by young hens whose egg production cycles are not yet completely synchronized. They're often produced too, by hens which are old enough to produce extra large-sized eggs. Genetics is a factor, also. Occasionally a hen will produce double-yolked eggs throughout her egg-laying career. It's rare, but not unusual, for a young hen to produce an egg with no yolk at all.

In fertilized eggs, the yolk is the site of embryo formation. It's the yolk which is responsible for the egg's emulsifying properties.

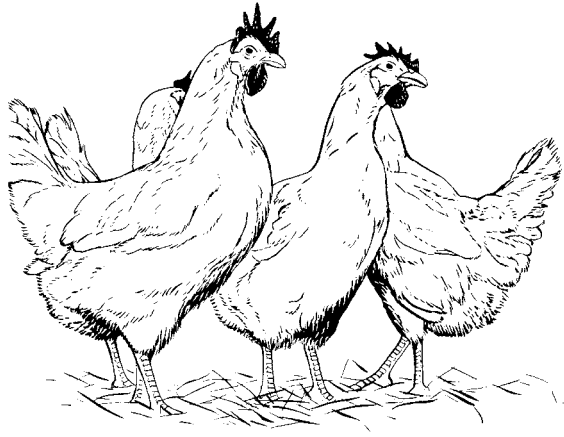
– See *Breakout; Color, Yolk; Composition; Fat; Fertile Eggs; Formation; Germinal Disc; Grading; Nutrient*

Zabaglione

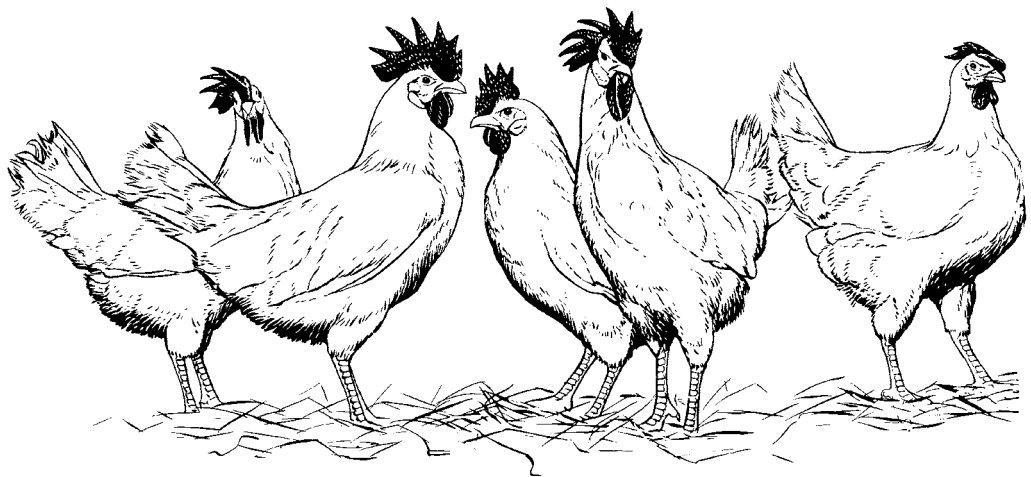
Italian dessert sauce made with egg yolks, marsala wine and sugar cooked over slow, simmering water.
Called Sabayon in France.

Zeaxanthin

–See Lutein



Raising Your Home Chicken Flock



RAISING YOUR HOME CHICKEN FLOCK

A successful home chicken flock requires good breeding stock combined with careful management, disease control, and a feeding program adequate for the production or growth level expected for the flock.

Why Have a Small Flock?

A small flock offers the convenience of having fresh eggs or poultry meat right at home and the possible reduced costs of production incurred by using available housing and farm feed-stuffs.

Poultry also can be kept as a hobby or as a learning experience for 4-H or FFA projects. Purebred poultry can be exhibited at fairs and poultry shows. There is also the pleasure of observing different shapes and colors in a home poultry flock. Purebred poultry may include chickens (large fowl and bantams), geese, ducks, turkeys, game birds, and guineas. Bantams are ideal for those who have only a small space available to keep chickens.

Before You Plan a Flock

Some local, county, state, and even federal zoning and environmental regulations prohibit poultry flocks. Zoning regulations are usually specific about animals and environmental considerations, such as flies, odor, and noise. Check with your county Extension agent or representatives of government agencies for approval before planning a flock. Also consider the proximity of your neighbors and their opinions.

Home flocks—even small ones—require water, food, and daily care including weekends, vacations, and holidays. The time and effort required for this care should be considered in weighing your desire for a home flock against other possible uses of your time and labor.

What Kind of Chicken?

There are two basic choices in the type of poultry to keep: a strain bred primarily for egg production or one that is bred for meat production.

Commercially available White Leghorn strains produce approximately 250 to 300 white eggs each year on a small amount of feed. Sexlinked hens, which are a little larger than Leghorns and lay brown eggs, produce approximately 180 to 240 eggs per year. Egg-producing stock can be bought as day-old chicks or as started pullets at 18 to 22 weeks of age. Yearling hens (hens with one year of production) can be purchased from a commercial egg flock.

The most economical meat production comes from commercial broiler-type birds, which can be used for broiler, roaster, and capon production. These meat birds typically produce few eggs.

Housing Requirements

Housing for home poultry production must keep the flock comfortable in all kinds of weather. The house should be tight, well-ventilated, and insulated. It is important to provide adjustable ventilation for adequate air movement in hot summer months and reduced air movement in cold weather. Litter is material such as shavings or sawdust spread on the chicken house floor. A concrete floor is recommended for sanitation and litter management; however, sandy soil may be adequate. Use a $\frac{1}{2}$ -inch ($1\frac{1}{4}$ -centimeter) mesh hardware cloth over windows to keep out birds, rodents, and predators.

Floor space in the house should allow 3 square feet (one square meter) per bird for layers and 1 square foot (315 square centimeters) per bird for broilers and bantams. Hanging cages are recommended as a means of preventing disease.

Brooding Equipment

Brooders

Baby chicks need heat during the first few weeks of rearing. There are many types of chick brooders that can be adapted to a small flock. Standard hover brooders can be used for starting a flock of up to 1,000 chicks. Battery brooders with feeders and waterers built in do a good job of starting chicks as well as supplying feeders and waterers for several weeks. The common infrared lamp is an inexpensive way to brood a small, 25- to 100-chick flock. The heat lamp should be at least 18 inches (45 centimeters) above the litter. In winter, make sure that the room temperature is warm enough to allow the heat lamps to be effective. A two-lamp unit provides safety in case one burns out during cold weather. Table 21 gives a temperature guide for brooding, but the behavior of the chicks is a better indicator of their comfort. If the chicks have loud, sharp chirps and are bunched near the heat source, they are cold. If they are panting and bunched in the corner away from the heat source they are too warm. A brooder guard usually is used to keep chicks near the heat source during the first week to 10 days. The guard is a circular barrier, 15 to 16 inches (38 to 46 centimeters) high, made of cardboard or other solid material, that confines the chicks and reduces drafts of cold air.

Feeders

Manufactured chick-feeder designs vary from the commercially used cardboard or plastic feeder lid to the metal trough type. Homemade boxes, egg flats, and similar low, open designs are acceptable as long as the chicks have easy access to the feed, and feed waste is controlled. Provide enough space so that nearly all the chicks can eat at the same time. To avoid feed waste, gradually change chicks to regular tube or trough feeders so that open feeders can be removed when the chicks are 10 days old.

Hanging tube and trough feeders for all ages are available from farm supply dealers. Hanging tube feeders are adjustable and can be used for chickens from one week through adulthood. Trough feeders have a limited capacity for adjustment, which makes it necessary to use at least three different sizes of feeders during the growing cycle of replacement pullets, roasters, or capons. At least two different sizes are needed to rear broilers.

A feeder can be built from scrap lumber, but it is critical that it be designed to avoid feed waste. The feeder must have a reel, grill, or other device to keep chickens from roosting on it or scratching in it. The feeder must have a lip to keep the feed from being spilled out. It is also essential that the feeder be the correct height (the back height of the chickens). See Table 20 for feeder space needs.

Waterers

Chicks must have easy access to water; much early chick mortality occurs when weak chicks cannot find water. Manufactured chick waterers are usually gallon or quart jars that screw onto special bases. Once filled, the waterers are inverted and the chicks drink out of the base. A simple homemade fountain, satisfactory for a dozen chicks, can be made by punching a hole with a 10-penny nail in the side of a standard can one-eighth of an inch (0.3 centimeters) to one-fourth of an inch (0.6 centimeters) from the open end. The can is filled with water and inverted in a deep saucer. Water fountains must be cleaned daily and filled as necessary.

Manufactured trough or low-pressure hanging waterers are usually used for growing flocks or adult home poultry flocks. Regardless of the waterer you use, make sure it has the following construction details: correct size and height from the floor (2 inches shorter than the back height of the chickens); a device to prevent roosting and wading; a design to control spillage; and a design for easy cleaning. Trough waterers usually can be adjusted for height; pan waterers do not have adjustments, but they work well over a pit area that catches spillage. Clean waterers daily so chickens have access to clean water at all times. Refer to Table 20 for water space needed.

Nests

Chickens kept for egg production should have access to nests at 19 to 20 weeks. Giving young pullets the opportunity to find nests 1 to 2 weeks before they start laying helps prevent them from developing the habit of laying in the litter. Both individual and colony nests are satisfactory. Leghorns should have a 12 by 14 by 12-inch (30 by 36 by 30-centimeter) individual nest; heavier hens should be provided with a 14 by 14 by 12-inch (36 by 36 by 30-centimeter) nest. Nail or glue a strip on the front of the nest to keep 1 to 2 inches (2½ to 5 centimeters) of nesting material in the nest. Provide one individual nest for every four hens in the flock.

A 2 by 6-foot (60 by 180-centimeter) colony nest is adequate for 50 hens. Nests may be placed on end walls or partitions. They should be installed high enough so hens can walk under them. Place nests with openings in the darker part of the house. Hens do not like to lay in nests with excessive light.

Roosts

Roosts provide comfortable sleeping for hens, replacement pullets, and capons. Roosts can be made easily by rounding edges of 2 by 2-inch (5 by 5-centimeter) or 2 by 4-inch (5 by 10-centimeter) boards. Allow 6 to 7 inches (15 to 18 centimeters) of roost space per bird. Dropping pits help with litter management: They catch a good portion of the birds' feces as well as water spillage. The dropping pit should be wire-covered and at least 12 to 16 inches (30 to 40 centimeters) off the floor. Clean the dropping pit regularly, particularly if wet conditions develop.

Light

Artificial light benefits all classes of poultry. One 40-watt bulb provides adequate light for 200 square feet (18 square meters) of floor space. If the ceiling is painted white or a light reflector is used, the quality of light is enhanced. A combination of natural and artificial light to give layers 14 hours of light is effective in maintaining egg production throughout the year. Broilers and roasters grow well with 24-hour light, but can be grown with only 8 to 10 hours, such as that provided by natural light.

Cages

Commercial table egg production utilizes cages in multiple tiers for more than 90 percent of eggs produced. Capital investment in cage layer facilities is high but labor efficiency is excellent. If hens are managed correctly and housed in well-built and well-ventilated buildings, their performance is comparable to that of floor layers. Odor and flies are major problems with cage rearing.

Table 20. Equipment Management Schedule

Chicken age	Brooding temperature	Feeding space	Water space
1 day to 1 week	90-95 °F (32-35 °C)	1 feeder lid per 100 chicks or 1 inch (2.5 cm) per chick trough (remove at 10 days)	1 gal (3.8L) per 100 chicks (remove at 10 days)
1 week to 3 weeks	1 to 2 weeks 85-90 °F (29-32 °C) 2 to 3 weeks 80-84 °F (27-29 °C)	2 inches (5 cm) per chick (one side of trough) or 3 tube feeders per 100 chicks	0.3-0.4 inch (0.75-1 cm) per chick (one side of trough with automatic fill or several 1 gal [3.8 L] fountain waterers or equivalent)

continued on next page

Chicken age	Brooding temperature	Feeding space	Water space
4 to 9 weeks	3 to 4 weeks 75-80 °F (24-27 °C)	3 inches (7.5 cm) per bird (one side of trough) or	0.5 inch (1.25 cm) per bird (one side of trough) or
	4 to 5 weeks 70-75 °F (21-24 °C)	4 tube feeders per 100 birds	Several 2- to 5-gal waterers
	After 5 weeks 70 °F (21 °C) room temp		
10 to 20 weeks	Comfort zone 55-75 °F (13-24 °C)	3 to 4 inches (7.5-10 cm) per bird (one side of trough) or 5 tube feeders per 100 birds	1 inch (2.5 cm) per bird (one side of trough) or Several 2- to 5-gal waterers
Layers	Comfort zone 55-75 °F (13-24 °C)	4 inches (10 cm) per bird (one side of trough) or 5 tube feeders per 100 birds (oyster shell or soluble grit feeders should be 12 inches [30 cm] per 100 birds)	1 inch (2.5 cm) per bird (one side of trough)

Feeding the Flock

Feed represents about two-thirds of the cost of raising a chicken. Commercial poultry farms use bulk feed programs in which a single delivery of 12 to 30 tons of commercial poultry feed is common. Such high-volume handling results in a relatively low cost per pound (or kilogram) of feed and explains why supermarket prices for poultry products are also relatively low.

The small flock owner deals in smaller quantities of feed—typically 50 or 100 pounds (22.5 or 45 kilograms)—and thus pays a higher cost per unit for feed.

Chickens must be fed an adequate diet for maximum productivity. Birds of different ages and utility have specific nutrient requirements, which are met by mixing together different feed ingredients. The scientific balancing of poultry rations is too complex for the home flock owner; therefore, commercial feed should be purchased, even if it seems expensive.

Table 21 outlines typical feeding programs for chickens of different ages and utility. When commercial programs differ from those outlined in the table, the commercial program should be followed. Use Table 21 only as a guide.

Commercial dealers usually have three different types of feed programs: all mash, mash and grain, and grain and supplement. Any of these feed-mixing methods are acceptable as long as the birds' nutrient needs are met. When part of the nutrient requirements for layers are expected to be met by whole grains, extra attention should be given to supplying adequate calcium.

All mash (crumble or pellet) feed is a complete ration and, when used, should be the only feed. Mash and grain feeds are formulated so that grain can be added to the mash. This feeding technique is useful for floor layers—feeding small amounts of grain in the litter causes the layers to scratch in the litter, thereby keeping it in better condition.

The grain and supplement program is convenient and economical for flock owners who have their own grain. When whole grains are provided it is recommended that a higher protein layer feed be used to ensure adequate nutrients to maintain high egg production.

Table 21. Typical Feeding Programs ^a

Layer	Layer replacement^b	Capon^b	Broiler^b	Roaster^b
20 weeks-production cycle Laying mash	0-6 weeks Starter	Same as layer replacement to 10 weeks.	0-3 weeks Starter 3-6 weeks Finisher 6 weeks-market Withdrawal	Same as broiler to 7 weeks of age.
May be fed all mash or mash-grain method.	6-13 weeks Grower or Pullet developer (15% protein)	Grower or Developer and grain prior to market. Grain gradually increased in diet up to 2 weeks prior to marketing.		Broiler Finisher and corn or whole grains until 2 weeks prior to marketing at 12-14 weeks. Insoluble grit may be fed if whole grain is used.
Free choice: Calcium (oyster shell or limestone) may be fed for good egg shells. Soluble grit may be fed if whole grain is used.	13-20 weeks Developer	Feed high protein mash, crumbles or pellets only during last 2 weeks.		

^a This schedule should be used as a guide only. Commercial company programs may vary from the one proposed. Choose a company's feeding program and follow it.

^b A suitable coccidiostat must be included in feed for young chickens (see poultry disease section). Read the feed tag or make sure your feed store provides a starter or grower with a coccidiostat.

Disease Management

It is important to consider several factors that relate to the quality and health of the flock once the type or breed has been chosen. Purchase stock only from reputable breeders or hatcheries. Stock purchased from magazine advertisements, especially bargain offers, can mean serious problems later. Stock should be purchased from pullorum/typhoid-clean flocks under the National Poultry Improvement Plan (NPIP). Pullorum/typhoid is a highly contagious disease. NPIP breeders, hatcheries, and facilities have been checked for proper management and sanitation and the absence of seriously diseased birds.

Diseases

Because of the similarity of many diseases, diagnosis should be left to a professional veterinarian. With an accurate diagnosis, proper treatment can be given to the flock. When there is an outbreak in the flock, take one or two birds showing typical symptoms to a diagnostic laboratory. When the diagnosis has been made, treat the disease under the direction of a professional veterinarian or with the advice of your county Extension agent or Extension specialist.

Respiratory diseases. Respiratory diseases affect the respiratory tract and are the most common diseases in chickens. Table 22 shows some of the common respiratory diseases; most can be prevented by vaccination.

Leukosis (Marek's). Leukosis, also called Marek's, is one of the most common killers of chickens of all ages. Birds with leukosis show many symptoms. Visceral leukosis results

in tumors on the liver and other organs; the bird becomes thin and dies. Another symptom, enlarged nerves, results in paralysis, with the bird eventually lying on its side unable to move. Gray eye is another form of leukosis, in which the iris shrinks, the eye turns gray, and the bird goes blind. Leukosis also can cause visibly enlarged bones.

Coccidiosis. Coccidiosis is the single most common cause of death in young birds. It is caused by single-celled coccidia that attack different parts of the intestinal tract, causing an irritation of the lining that prevents the absorption of food. In minor outbreaks, the birds are droopy, have ruffled feathers, and lose weight. Egg production in older birds declines. Severe cases result in hemorrhage and death. Practically all poultry house litter contains coccidia; it is important to keep litter dry and to purchase feed that contains a coccidiostat. Chickens kept in cages normally do not have problems with coccidiosis.

Table 22. Common Respiratory Diseases

Disease	Symptoms
Infectious bronchitis	Rapid spread; gasping; wet eyes; coughing; swollen sinuses; drop in egg production; misshapen eggs; rough- or soft-shelled eggs; watery egg whites; death
Newcastle	Rapid spread; gasping; rattling; loss of appetite; coughing; huddling; paralysis of legs; twisted neck (stargazer); walking backward; drop in egg production; soft or misshapen eggs; death
Laryngotracheitis	Slow spread; coughing; sneezing; sitting hunched on floor; emitting a cawing sound; coughing bloody mucus; nasal discharge; swollen head and wattles; drop in egg production; death
Fowl pox	Skin - White to yellow bumps on comb, face, or wattles turning to scabs Internal - Cankers in membranes of mouth, throat and windpipe; difficulty breathing; nasal or eye discharge
Coryza	Thick nasal discharge with odor; swollen sinuses; ruffled feathers; difficulty breathing
Mycoplasma	Difficulty breathing; ruffled feathers; nasal discharge; rattling; facial and nasal swelling; weakness; drop in egg production; swollen joints; yellowish feces
Cholera	Droopiness; difficulty breathing; loss of flesh; drop in egg production; purplish swollen head, comb, and wattles; paralysis

External parasites. External parasites cause losses if proper prevention and treatment procedures are not followed. Chickens should be checked once a week for signs, as shown in Table 23. Consult with your county Extension agent for procedures and chemicals for prevention and control. Follow directions on packages of chemicals.

Internal parasites. Internal parasites are worms found in the digestive and respiratory tract. Often insects, such as beetles, act as the intermediate host. Insects carry the worm eggs, which are deposited in the chicken after the chicken eats the insect. Common internal parasites are listed in Table 24. Chemicals for the prevention and treatment of internal parasites should be administered under the direction of a competent authority.

Other diseases. Other diseases are not as common and require a professional diagnosis. Moldy feed causes mycotoxins and losses. Chickens develop nutritional deficiencies if they are not given a well-balanced diet. Highly pathogenic transmissible diseases, such as Exotic Newcastle and Avian Influenza, can be avoided with proper management and biosecurity measures.

Table 23. Common External Parasites

External parasite	Symptoms
Chiggers	Red, pimple-like irritations
Lice	Large, yellowish, transparent insects on the skin; low weight; blackish discoloration (dirty) in the vent and tail area; drop in egg production
Mites	
Red (roost)	Loss of weight; red specks; death
Northern fowl	Red or black specks around vent; unthrifty; drop in egg production
Feather	Loss of feathers; webs irregular with only shafts left in some cases
Scaley leg	Enlarged shanks and toes with raised, crusty scales

Table 24. Common Internal Parasites

Internal parasite	Symptoms
Large roundworm	Long, yellow-white worms in intestine; droopiness; weight loss; diarrhea; death
Capillary worm	Hair-like worms in crop and upper intestine; droopiness; weight loss; death
Cecal worm	Short worms in the ceca; unthrifty; weak; loss of flesh
Tapeworm	Long, white, flat, segmented worms in intestine; unthrifty; slow growth; weakness
Gapeworm	Red, forked worms in trachea; gasping; coughing

Sanitation

Lack of cleanliness is often the cause of poultry disease. There are several sanitation measures that should be taken in a home chicken flock: 1) complete cleaning and disinfecting of house and equipment before starting baby chicks or housing layers; 2) daily cleaning of waterers; 3) screened manure pits under roosts, feeders, and waterers; 4) managing litter to keep it dry and clean; 5) incinerating, burying, or composting all dead chickens; 6) raising young stock away from adult chickens; 7) isolating the flock from outside traffic (chickens raised off the farm, neighbors, birds, dogs, etc.); 8) practicing good housekeeping and rodent control; and 9) disposing of litter and manure by spreading and plowing or spading the manure under soil. Manure and litter should be spread or stored in areas not used by poultry.

Biosecurity

Biosecurity includes management practices that prevent the entrance of germs and disease into the flock and into neighboring flocks. There are several biosecurity measures that must be taken: 1) purchase healthy stock; 2) keep your birds confined—do not let them run loose; 3) keep dirty equipment and materials from other flocks away from yours; 4) do not mix domestic birds with wild or caged birds, such as parrots and canaries; 5) medicate properly and follow directions; 6) keep unfamiliar people and others who might be carriers of disease away from your birds; 7) control vermin, such as rats and mice; 8) practice an insect-control program; and 9) keep pen areas weed- and debris-free and keep buildings in good repair. Rely on professionals, such as veterinarians, Extension agents, animal health suppliers (those who sell vaccines and medicines), and universities for educational materials and help.

Beak Trimming

Chickens are cannibalistic. The best way to control cannibalism is with beak trimming. The chicken's beak is just like a human fingernail; this procedure is not painful. If chicks are beak trimmed at 1 day old in the hatchery, and again once or twice before they reach 16 weeks, they probably will not develop the pecking habit.

With a knife or scissors, cut off at least one-third of the upper and one-eighth of the lower beak. Commercial equipment uses electricity to cut and cauterize the beak (sear the cut tip). Cauterizing can also be simulated with a hot iron after the beak is cut. If cauterizing is not possible, cut only the amount of beak that can be removed without severe bleeding, in most cases about one-fourth.

Home Processing

The quality of a ready-to-cook chicken is only as good as the live bird. When choosing chickens to be processed, look for healthy, well-finished chickens that are free of pinfeathers. Consider the weight and age that are desirable for your particular need.

For good flavor, it is essential that the chicken be well bled. One of the best methods of killing and bleeding is to cut the jugular vein (on each side of the neck). During this process, the chicken should be hung so it will not bump other objects or get soiled.

Immersing the chicken in hot water so that feathers are easily removed is called scalding. Scald water temperatures for broilers, roasters, and capons should be 128 to 130 °F (53 to 54 °C) and 155 to 160 °F (68 to 71 °C) for older chickens (spent layers, etc.). Scald for approximately 1½ minutes for adequate feather removal.

Remove the head, feet, and viscera. Wash the eviscerated chicken with clean water and chill it in ice water for several hours to reduce body heat. Chilling is necessary to produce a quality product and prevent spoilage. Add a teaspoon of chlorine bleach to each ten gallons of ice water for added protection.

Egg Handling

The egg is called nature's perfect package, but if it is soiled or broken, the package is of little value. A clean nest, ample nesting material, adequate space, and twice-a-day gathering (more often in hot weather) are the most important factors in producing sound, clean eggs. Once gathered, eggs should be refrigerated.

Poultry Product Sales

There may be times that you have a surplus of product and wish to sell it. Home flock products often command a premium price because of their quality and freshness. Become familiar with quality factors for meat and eggs before selling your product. Study educational materials on grading factors, packaging, storage, and marketing. Remember, you face the same risks in selling products as large producers do, and you want to ensure repeat sales to your customers.

Residues

Be sure that you do not sell products that contain residues of chemicals or drugs used on or around your home chicken flock. Residues are chemical compounds in meat or eggs. They are difficult to eradicate and can cause health problems in people who eat the products. The chemicals may have been in the flock's feed or water or come from pesticides or herbicides dusted or sprayed around birds or facilities. It is important to follow label instructions when using any chemicals around poultry. There is a withdrawal period for most drugs used in feed or drinking water; be aware of this period. Consult professionals when you have a question on the use of any chemical or drug product.

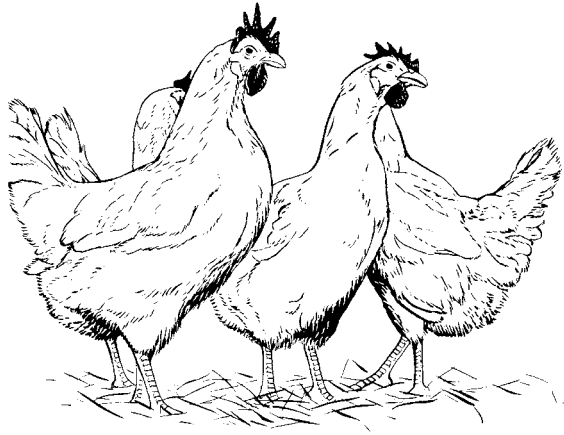
Exhibiting Poultry

Many small flock owners like to exhibit their birds at fairs or in poultry shows. You can enter commercial or purebred poultry in most fairs; poultry shows accept purebred poultry only. Purebred birds are shown by breed or class as identified in the American Poultry Association's *The American Standard of Perfection* or American Bantam Association's *The Bantam Standard*, which list the classes and descriptions for each breed and variety. A variety may be the shape, color, or comb type for a particular breed. Many breeds have several varieties. Selecting birds and carefully preparing for the fair or show are essential to providing a good exhibit and increasing your chances to receive a prize.

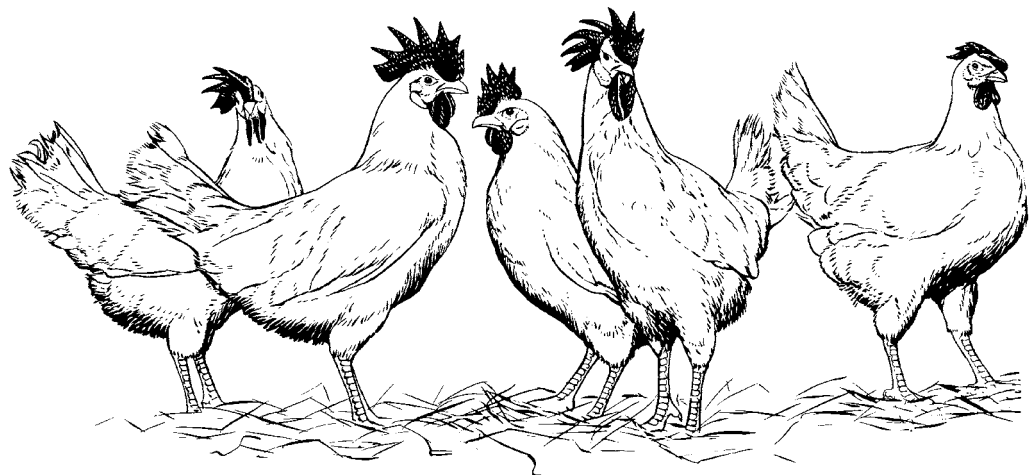
Conclusion

Raising a home chicken flock can be a good experience and a source of enjoyment. As a family project it teaches about living beings and responsibility. The home chicken flock also can be an excellent source of low-cost, high-quality poultry products. This chapter should provide the basic tools to start a successful flock.

Acknowledgments: Charles J. Wabeck, Extension Poultry and Food Products Specialist Lower Eastern Shore Research and Education Center, Princess Anne Facility



General Care of Pet Birds



GENERAL CARE OF PET BIRDS

The cockatiel (*Nymphicus hollandicus*) is a small (about 100 grams) parrot, which is native to Australia but has been bred in captivity for generations. Cockatiels have beaks that are well-adapted for chewing and biting, and they are strong flyers. They are also easily tamed and may live up to 20 years. These factors should be considered before buying a pet cockatiel.

Caging

Cockatiels should be kept in cages large enough for the bird to flap its wings. In smaller cages the tips of the bird's feathers may be shredded as the wing tips are beaten against the wire. Cages with horizontal dimensions of at least 18 inches are usually adequate, but, especially if the bird does not get out to exercise, a larger cage is better. There should be one and preferably two perches, a waterer, and a feeder. The floor should be wire under which a tray is placed to catch droppings. Sheets of newspaper are good litter for the tray. They are dry, cheap, and readily available. Do not place the perch directly above the feed or water or they will become contaminated with droppings.

Feeding

There are several feed companies that offer complete diets for cockatiels in a crumbled or pelleted form. These diets require no extra supplements to assure that your pet gets all the nutrients it needs. Often a mix of seeds is fed to pet cockatiels. This is available in pet shops in small bags for the pet owner. The pellets or seeds can be placed in the feeder and should be available to the bird at all times. Be aware that seeds have hulls which cockatiels remove when they eat. These hulls can pile up in the feeder and give the impression that the feeder is full of seeds. A feeder full of hulls contains no food for the cockatiel, and eventually the bird will starve unless the feeder is filled with seed. If you are not sure whether your feeder is full of seed or hulls, simply blow on the feed. The hulls will be easily blown away while the seed remains. In a similar way, some birds will not eat the powdery remains of the pelleted diets, so they may need to be removed and new pellets added.

While a crumbled or pelleted diet alone is adequate for long-term maintenance of a cockatiel, a seed diet is not. The nutrient requirements of an adult, non-breeding bird are low, but there are some essential trace nutrients which are lacking in seed alone. There are several approaches to supplying these trace nutrients. One is to buy a supplemented seed mix in which some seeds are coated with a mix of trace nutrients. Another is to add nutrients in the form of water soluble premixes to the water once or twice a week. These premixes are available in pet stores. A third method is to vary the bird's diet by feeding fruits and vegetables. All three of these methods can work for a pet bird. With the premix method it is important to clean the waterer after—but no longer than one day after—adding the premix to avoid bacterial growth in the waterer. When the seed diet is supplemented with other foods, it is important to be sure that the bird is eating the added food. If it is not then try another method. When supplementing the seed diet avoid drastic, sudden changes in the bird's total diet. Some birds will reject the supplements and others may eat to excess and develop digestive problems. This problem is easily avoided by keeping the feeder full of seeds and limiting the amount of supplemental feeding.

Fresh, clean water is also essential for the good health of a pet bird. The water should be changed daily.

Environment

A bird in a cage has no chance of changing its environment by moving to a more comfortable place as a bird in the wild can. This makes it important to put the cage in a place where the bird can be comfortable. The cage should be placed in a draft-free area, out of direct sunlight. Avoid placing a birdcage near south windows, particularly in winter; air conditioners; heaters; kitchens, unless the bird is away from sources of heat such as stoves, ovens, microwave exhausts, refrigerator backs, and sinks full of hot water; vents; open windows and doors; and hot lights or electrical equipment such as televisions.

Exercise, Escape, and Hazards

You may often want to take your pet out of its cage to play with it or let it fly around. There can be problems with allowing the bird out of its cage unless the bird is watched and some precautions are taken.

Since cockatiels are strong flyers, they often escape out open windows or doors. Obviously, the doors and windows should be shut if the bird is out, or the bird's wings should be clipped so it cannot fly. Some birds still unfamiliar with the area where they fly will fly into windows or mirrors and injure themselves. This can be avoided by closing drapes and avoiding rooms with mirrors.

Birds that have clipped wings have a different kind of potential problem. They cannot fly to avoid danger. These dangers can include other pets such as cats and dogs and the possibility of being stepped on. These hazards must be considered for your individual circumstances. The most important thing you can do is to keep track of your pet and intervene when a hazardous situation arises.

Chewing is a major concern. Cockatiels will chew almost anything. Some of the things they chew will be damaged or may hurt the bird. You must use your judgement here, but it is best simply to watch the bird. If you cannot watch it, put it back in its cage.

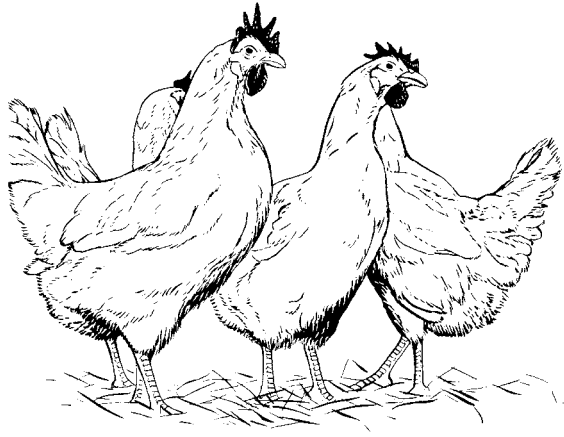
Health Care

Taking on the responsibility of owning a cockatiel also means providing proper veterinary care should the need arise. Cockatiels are generally very healthy, but if a bird appears listless, is fluffed up for long periods and/or is not eating its normal amount of feed, a visit to a veterinarian is advised. If you do not have a regular veterinarian, you should try to find one who has experience with birds.

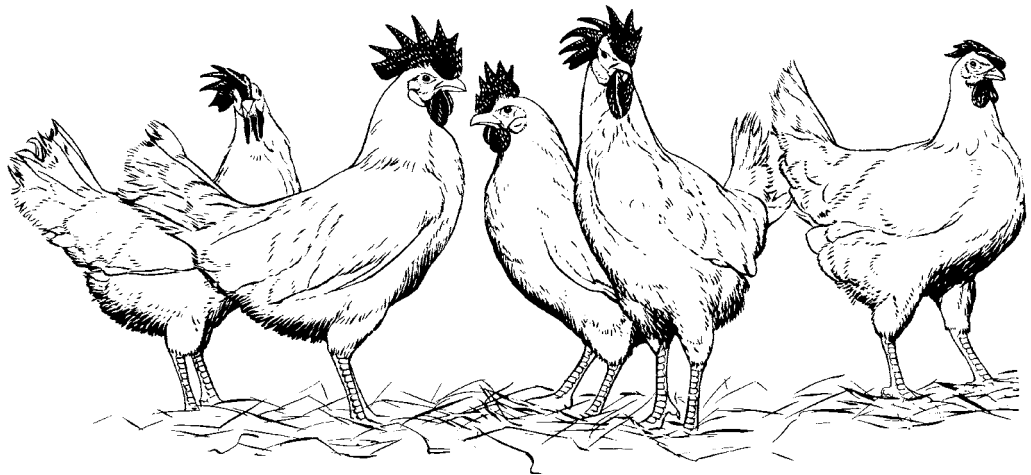
Summary

Providing the essentials for a pet cockatiel as discussed above should result in having an entertaining, affectionate avian companion for many years. For more information on such topics as breeding your pet cockatiel and learning about various color mutations, you may want to contact a local bird club in your area or write one of the two national cockatiel organizations. The National Cockatiel Society or American Cockatiel Society

Acknowledgments: Psittacine Research Project, Department of Avian Sciences, University of California, Davis, CA 95616



Fact Sheets



CONTRIBUTIONS OF POULTRY TO THE DEVELOPMENT OF SCIENCE

BACTERIOLOGY (study of bacteria)

Anthrax, an infectious disease which causes high fever and even death in affected animals, was a huge problem in livestock in the 1800's. Louis Pasteur (1822-1895) suggested that chickens did not get the disease because they have a high body temperature (41.5 °C). He injected a normal hen with anthrax bacteria and she lived. He injected another hen with anthrax bacteria and submerged her partially in water to lower her body temperature. The hen with the lowered body temperature died from anthrax.

Pasteur also worked with the disease known as fowl cholera. He found that if he cultured the bacterium that caused the disease (by growing it in a fluid especially prepared to nourish the cells) and gave a drop of culture to a chicken, the chicken would die. However, if he gave a drop of an OLD culture of the disease to a chicken, it exhibited a mild form of the disease and became immune (resistant) to the disease.

With this information, Pasteur was able to develop an attenuated virus vaccine against anthrax. Attenuated means that the strength of the disease-causing agent has been reduced by passing it either through animals other than the animal that normally contracts the disease or through culture. An example would be growing cattle plague bacteria in a chick embryo to make a vaccine that protected sheep from anthrax. This process also led to the work that developed vaccines against diseases such as tetanus and typhoid.

BEHAVIOR

T. Schjelderup-Ebbe (1894-1976) provided the first scientific observation of social behavior in animals in 1935. He described the ranking behavior or "peck order" that exists in a group of hens, documenting how one hen will always be dominant to all the other hens.

Konrad Lorenz (1903-1989) received the Nobel Prize for demonstrating imprinting with ducks. He showed that ducklings will identify as their parent the first object or person they see when they hatch.

BIOLOGICAL ASSAYS

It's often necessary to establish the vitamin content of various foods. A vitamin is a substance present in natural foods which is essential for good health. An animal may synthesize a vitamin in its own body; however, by definition the animal cannot make all of the vitamins it requires for good health. Since young chicks are very susceptible to vitamin deficiencies, they have been used as a biological check for chemical methods that measure the vitamin content of foods.

EMBRYOLOGY (study of formation and development of embryos)

Hieronymous Fabricius (1533-1619) pioneered the study of embryological development using the chick embryo.

ENDOCRINOLOGY (study of hormones and hormone-producing glands)

Arnold A. Berthold (1803-1861) has been called the father of endocrinology. In 1849, he removed the testes from one cock. The cock's comb became smaller and grew pale. When he transplanted testes into a capon (a castrated male), the bird again took on the appearance of a normal male. This was the typical sequence of events as long as the transplanted testes established a good blood supply. However, if a blood connection failed to form with the transplanted testes, the bird continued to lack the male appearance. This established the fact that the testes were producing some substance that traveled in the blood and gave the chicken its sex characteristics.

GENETICS

Johann Gregor Mendel (1822-1884), the Catholic monk known as the father of genetics, conducted his pioneering research on peas. In 1866, he described what was to become known as Mendelian genetics. In 1898, William Bateson (1861-1926), working with chickens, was the first to demonstrate that Mendel's laws applied to animals. Bateson found that both rose combs and pea combs were dominant to single combs.

GNOTOBIOTICS (study of organisms raised in germ-free conditions)

Louis Pasteur addressed the French Academy of Sciences in 1885 on the topic of “germ-free hosts.” In order to study the influence of microflora (the microscopic and specialized organisms found in an animal’s digestive tract) on its host, the scientist must also be able to study hosts that are germ-free. It’s difficult to produce a germ-free mammal. Pasteur proposed that the chick was the most suitable model. If eggs are obtained from healthy hens, are incubated in a sterile incubator, and upon hatching are fed sterile food and water, they will be germ-free.

IMMUNOLOGY (study of mechanisms by which organisms resist and overcome infection and disease)

In 1956, Bruce Glick found that lymphocytes (a specific type of white blood cell) in the chicken’s Bursa of Fabricius (the small, sack-like structure found in the cloaca of young birds) were responsible for antibody production. These lymphocytes became known as B-lymphocytes (B for bursa-derived).

VIROLOGY (study of viruses and viral diseases)

The first evidence that a virus could cause cancer came in 1911 when Francis Peyton Rous (1879-1970) discovered that the Rous sarcoma virus caused cancer in chickens. Rous won the Nobel Prize in 1966 for this work.

In 1969, A. Churchill developed a vaccine against the Marek’s disease virus. This was the first control of a significant neoplastic (cancerous growth) disease in any species.

VITAMIN DISCOVERY

In 1897, Christian Eijkman (1858-1930), a Dutch physician working in Java, discovered that hens fed a diet of polished rice became paralyzed. The chickens’ paralysis looked very much like the symptoms of human patients in the clinic where he worked. Humans were suffering from Beriberi (an impairment of the nerves and heart). When the birds were fed unpolished rice, they recovered. Eijkman’s discovery paved the way for the whole concept of vitamins. The pioneering work of Dr. Eijkman culminated in the discovery and isolation of vitamin B1, or thiamine. This important compound was contained in the bran or outer layers of rice; the bran had been removed when the rice was polished.

In 1930, Henrik Dam (1895-1976) found that chicks fed diets very low in fat developed an illness that caused them to hemorrhage. The blood of these chicks did not clot as fast as the blood from chicks fed a normal diet. In 1935, Dam discovered that the substance needed for good blood clotting was a factor that was found in green leaves and certain vegetables. He called it the “Koagulations” vitamin; in his native Danish, “coagulation” is spelled with a “k.” Therefore, the factor was named vitamin K.

*Francine A. Bradley, Ph.D., Extension Poultry Specialist Emerita,
University of California, Davis*

RATITES

A **ratite** is a family of large flightless birds with a flat, keeless breastbone. The keel bone of birds of flight is important for supporting pectoral flight (breast) muscles. Although ratites are flightless, they do have small wings which they use for cooling, for balance during running, and during courtship displays. Ratites are polyphyletic, which means they have descended from more than one evolutionary line. Some ratites can be kept as companion animals and pets. Recently in the United States they have been raised for their meat, feathers, and hide as well as other products such as oil. Ratites include such birds as rheas, kiwis, cassowaries, emus, and ostriches.

RHEAS

The rhea is from the order Rheiformes and the family Rheidae. There are two rhea species: the greater rhea (*Rhea americana*) and the lesser or Darwin's rhea (*Pterocnemia pennata*). Both are native to South America. The Rhea americana is the largest bird of the Americas, and because of this, it has several nicknames, including the "American ostrich" or the "Pampas ostrich." The greater rhea lives on the pampas (plains) of Brazil, Bolivia, and Argentina. The lesser rhea is found in the Andean foothills of Peru.

The rhea has three toes, and it does not have a hind toe (hallux). Rheas have long legs and necks, and they are 4 to 5 feet tall. Unlike the ostrich, the neck of the rhea is feathered. Rheas weigh 70 to 90 pounds. The male is larger than the female, and their diet consists primarily of roots, seeds, insects, lizards, and some small mammals. The male has a harem of 6 females, and each female lays about 15 to 18 eggs. In the United States, they lay eggs from late spring until fall. The male does the incubation of the eggs, which are laid on the ground in a nest called a scrape. Incubation lasts 30 to 43 days and the male continues to tend to the chicks until they are 4 to 5 months of age. The rhea is raised for its meat, feathers, and hide.

KIWIS

The kiwi is from the order Apterygiformes and the family Apterygidae. There are three species of kiwi: the little spotted kiwi (*Apteryx oweni*), the great spotted kiwi (*Apteryx haasti*), and the brown or common kiwi (*Apteryx australis*). The kiwi is the smallest ratite and is a nocturnal bird. The kiwi is the national bird of New Zealand and is now a protected species there.

They inhabit dense forests, wetlands, swamps, and moist forested areas. Hunting and the introduction of mammals from outside New Zealand has devastated the population.

The kiwi is sometimes called the "woodcock ostrich" because it has a long, slender, curved bill with nostrils at the tip which aid in their well-developed sense of smell. They use their excellent sense of smell along with their toes, which have tough claws, for excavating earthworms (their primary diet) and other small invertebrates at night. Because they are nocturnal, they have poor eyesight but a well-developed sense of hearing. They spend much of the day underground in burrows which are lined with twigs, grass, and feathers. The kiwi has hair-like feathers, and very small wings hidden beneath these feathers, which create a sleek, contoured appearance. The kiwi is only 15 inches high, weighs anywhere from 2 to 10 pounds, and has no tail.

The kiwi lays the largest egg in relation to body size. The egg weighs 1 pound (454 grams), which is approximately 10 percent of its body weight. The female lays one or two eggs between July and February in New Zealand; in this country, they lay eggs from late fall to spring. They have both a right and left functional ovary, unlike other birds which have only a left functional ovary. The incubation is 75 to 78 days and is done by the male. When the chicks hatch, they are not fed for 6 to 12 days. Chicks are feathered at hatch and are not covered by down. The birds do not breed until the age of 5 or 6. Since kiwis are protected, they are not raised commercially.

CASSOWARIES

The cassowary belongs to the order Casuariiformes and the family Casuariidae. They are native to New Guinea and Australia. There are three different species of cassowaries. The "double wattled" cassowary is 6 feet tall and is found primarily in New Guinea and the rain forest of northeast Australia. The "single-wattle" cassowary is 5 feet tall and can be found in the coastal swamps of New Guinea, while the "dwarf" cassowary, which is only 3½ feet tall, is found in the mountain forests of New Guinea.

Cassowaries have adaptations which protect them from the dense undergrowth. For example, the feathers on their wings are only quills and are very coarse so that they are not easily damaged from the vegetation. Another adaptation is the “casque” on the top of their head, which is a flattened bony “crown” that protects the head while allowing the cassowary to part vegetation with it.

The adults have a sharp claw on the innermost toe which is used for defense. They also have thick double feathering which gives them added protection. They eat primarily fruit and leaves.

Cassowaries are monogamous, live in pairs or family parties, and each pair defends the territory during breeding season. The greenish eggs are laid from May to September in New Guinea and Australia and from late fall to early spring in this country. There are usually three to eight eggs in a clutch. The male does the incubation and brooding; the incubation period is 49 days. The cassowary is not being developed for the commercial market.

EMUS

Emus are in the order Causuariiformes and the only existing member of the family Dromaiidae. They are natives of Australia and are the second largest living bird. They stand 5 to 6 feet tall and weigh in the range of 110 to 140 pounds. The female is larger than the male. They are widespread on the Australian continent and considered a pest by some farmers because they can destroy fences while seeking cultivated crops. They have been hunted to extinction on some of the islands surrounding Australia. The emu has three toes and a bill, which is soft and broad and adapted for browsing and grazing. They feed on fruits, flowers, insects, seeds, green vegetation, caterpillars, beetles, and grasshoppers.

Each gray, hair-like feather has two identical shafts with barbs that do not interlock to form the traditional feather vane. The blue skin on the neck is not covered with feathers. The emu is a shy bird and can travel in excess of 30 m.p.h. to escape confrontations, and their long legs carry a powerful kick. Emus are also good swimmers.

The female emu lays a clutch of 9 to 12 dark green eggs and the male does all the incubation of the eggs. Each egg weighs 1 to 1½ pounds and the incubation period is 56 days. The proper incubation temperature is 91 °F. The chicks are hatched and they leave the nest after 2 to 3 days. The emu reaches sexual maturity at 2 to 3 years. They usually breed from May to August in Australia; in the United States, the emu breeds from October to May.

The emu is grown commercially for its meat, feathers, hide, and oil. The oil is used by the Australian Aborigines as a healing agent, anti-inflammatory agent, and as an analgesic (topical pain killer).

OSTRICHES

Ostriches are of the order Struthioniformes and the family Struthionidae. There is only one species of ostrich, *Struthio camelus*, “camel bird.” The ostrich is the largest bird, with the adults usually reaching 6 to 8 feet in height and weighing 250 to 400 pounds. Despite their size, they can run about 40 m.p.h. Ostriches are the only ratite that have two toes, which are adapted for running and walking. They also have a very powerful kick. One toe has a long nail, which is used to lash out at predators. Although the ostrich originated in Asia, it is considered a native of Africa. There are several subspecies of *Struthio camelus*. The Arabian ostrich, which was common in the deserts of Syria and Arabia, was hunted to extinction for sport and for its plumes. The southern subspecies is found primarily in southwest Africa and Angola. There are two subspecies with red necks, the North African ostrich (*S. c. camelus*) and East African ostrich (*S. c. massalcus*), found primarily in Northern Africa. There are two blue necked ostriches, the Somali ostrich (*S. c. molybdophanes*)—found in the bush country of Kenya, Ethiopia, and Somalia—and the South African ostrich (*S. c. australis*). The Masai ostrich, another subspecies, is found in Kenya and Tanzania.

The male ostrich is larger than the female and has black body feathers with a brownish rump and white wing and tail feathers. The females have brownish-gray body feathering. Ostriches have keen eyesight. Ostriches are omnivorous. They primarily eat plants, fruits, seed, leaves, shoots, and succulents but will eat invertebrates and lizards as well.

Ostriches are polygamous; there can be one male for four or five females. The breeding season is from March to September in the United States. In the wild, the nests are shallow pits dug in sandy soil with a clutch of 12 to 36 cream-colored eggs. Commercially, ostriches are raised in pairs or trios, and each hen lays between 40 to 60 eggs. The ostrich egg is the largest egg. It weighs approximately 1.4 percent of the female’s body weight at about 3 pounds, with a shell that is 2 millimeters thick. The incubation period lasts 42 days. The hen incubates the eggs during the day, while the male incubates the eggs at night. Commercially, eggs are placed in incubators. The young are precocial, and at one month of age they can run as fast as an adult.

Ostriches have been raised commercially in South Africa since 1850. The United States had a commercial ostrich industry based on the feathers until 1930, but the Great Depression and changes in fashion resulted in its demise. Recently, there has been a renewed interest in the commercial ostrich industry. Ostriches are now being raised for their feathers, meat, and hide. Ostriches are processed at 12 to 14 months of age and produce about 80 pounds of boneless meat, 15 square feet of hide, and about 3 pounds of feathers. The meat is red in color, low in fat and cholesterol, and high in protein.

*Michelle A. Hall, Professor Emerita,
Animal & Veterinary Science Department, Clemson University*

THE COMMERCIAL POULTRY INDUSTRY

INTRODUCTION

The commercial poultry industry is divided into three main divisions, the turkey industry, the chicken meat or broiler industry, and the egg industry. The rise of the commercial chicken and egg industries began when chicken farmers decided to raise separate breeds of chickens for egg production and meat production. Today, the breed most commonly used for commercial egg production is the Single Comb White Leghorn, while the modern meat-type chicken or broiler comes from a cross between a White Plymouth Rock hen (female) and a Cornish cock (male). The turkey industry primarily uses a strain of bird called the Beltsville White.

HISTORY

The commercial broiler industry was begun in 1923 by Mrs. Cecile Steele in Sussex County, Delaware, when she started a flock of 500 chicks and sold them when they reached 2 pounds. The following year, she started 1,000 birds, and by 1926 she was producing 10,000 birds under one roof. These early broilers were actually heavy laying breeds like New Hamshires, Rhode Island Reds, Barred Plymouth Rocks, or White Plymouth Rocks.

Commercial flocks of 1,000 or more hens began appearing on the east and west coasts in the 1870's. During the 1930's, Petaluma, California, became one of the most intensive egg producing areas of the country. California produced so many eggs, which were shipped all across the country, that Petaluma became known as "The Egg Basket of the World." By the 1960's, with the promotion of contract production and an excellent transportation system for grains, much of the industry shifted to the Southeast, although California still remains one of the largest commercial egg producing states.

One could say that the turkey industry began with the first Thanksgiving in 1621, where wild turkey was served. In fact, the modern turkey industry relies upon a type of bird that owes its origins to the Broad Breasted Bronze, the White Holland, and the Beltsville White. The turkeys used by the turkey industry today are not designated by breeds or varieties but by strains such as the "large," "medium," and "small" type of hybrid white crosses. White turkeys are used because when the feathers are removed, there are no dark or black pin feathers left in the skin.

PRODUCTION AND MARKETING

In order to reach a decision to enter into poultry production, careful consideration must be given to the products being produced, types of markets available for those products, the demand for those products in the area to be serviced, and the scope of the production unit planned. The poultry industry is a vertically integrated industry. **Vertical integration** is a marketing term that means combining related marketing functions and decisions into a single firm. This means that one company controls the feed mill, hatchery, breeder flocks, growout flocks, processing, marketing, and sales of the product. Vertical integration allows for a shorter, more direct movement of the product from the farm to the table.

The poultry industry also uses a **contract production system**. In a contract production system, a grower of the birds enters into an agreement with a poultry company to provide the land, housing, utilities, and management skills required to raise broilers, turkeys, or egg producing chickens. The company owns the birds put onto the farm, provides the feed, veterinary care, and guidance to the farmer. The company also agrees to pay the farmer so much per pound of chicken or turkey meat produced or so much per dozen eggs.

Today, the commercial poultry industry produces more meat and eggs on fewer farms because of careful genetic selection, advanced nutrition programs, developments in better housing, and carefully supervised management systems. Achieving higher production levels with fewer sources is a situation known as an **economy of scale**.

CAREERS

Since the world will always need food, food industries such as the poultry industry will always be looking for well-educated individuals to carry it into the 21st century. Poultry is America's choice because of its nutritional value and because of its cost efficiency.

Since the poultry industry is such big business, there is a wide variety of occupations to support it—people are needed to manage breeder farms, hatcheries, feed mills, and processing and packaging operations. Those are just a fraction of the jobs available: Consider the transportation, animal health, marketing, sales distribution, technical

support, construction, maintenance, education, accounting, training, and administrative activities needed to keep the poultry industry moving ahead.

There are also allied industries that provide financing, equipment, pharmaceuticals, supplies, computer support and services. Here are some examples of careers available in the poultry or allied industries:

Advertising/Public Relations	Growout/Breeder Management
Bioscience/Biomedicine	Home Economics
Business Management	Live Production
Computer Science/Data Management	Personnel
Distribution/Sales/Marketing	Pharmaceutical
Poultry Health/Veterinary Medicine	Engineering
Food Science/Food Safety	Poultry Nutrition
Product Development/Quality Control	Genetics
Government Agencies	Research/Teaching/Extension

Field Operations - If you feel that living and working close to nature is a rewarding way of life, you may choose a career that lets you do just that. There are many field-related jobs such as breeder manager, growout farm manager, flock supervisor, hatchery manager, or feed mill manager. Billions of birds and tremendous capital investment are required for today's modern poultry production.

Research and Technical Support - If you dream of making discoveries that can change the world, then the poultry industry can be a dream come true. The results of research and scientific development are put to work in the industry almost every day. Scientists are continually studying biotechnology, genetics, nutrition, vaccines and disease control, waste recycling, environmental protection, quality control, food safety, and product development.

Sales and Marketing - If you're a creative, imaginative "people person," a form of marketing communications like advertising or public relations would be an excellent career challenge for you. The poultry industry employs sales or marketing management professionals.

Computer Science - The poultry industry also needs individuals who are familiar with computer programming, information systems, or database management. Every facet of the poultry industry is computerized—from feed mills and hatcheries to processing plants and distribution. Modern poultry houses also have sophisticated computer management systems to monitor ventilation and temperature.

Business - The poultry industry offers job opportunities in management, finance, accounting, engineering, purchasing, and personnel.

Allied Industries - A career in poultry doesn't necessarily mean you'll be working with animals. Allied industries provide supplies, products, or services to the poultry industry. Examples include jobs in the pharmaceutical industry, feed milling, equipment manufacturing and sales, distribution, government, and teaching.

The World Poultry Market - Because the poultry industry is so diverse, it's possible to find a job close to home, across the country, or around the world. To keep up with increasing consumption and expanding world demand, poultry production is growing and so are the job opportunities.

Michelle A. Hall, Professor Emerita
Animal & Veterinary Science Department, Clemson University

THE CHANGING WORLD OF POULTRY AND EGG MARKETS

Definitions:

Demand - the quantity of a product that consumers/buyers desire. “Quantity” is the amount of the product that consumers will buy at a given price.

Embargo - governmental order that has the effect of completely limiting trade between one country and another.

Promotion - the act of publicizing a product, in order to increase sales or visibility.

Sanction - governmental trade prohibition on specific products and/or services to another country. Sanctions can be thought of as partial embargoes and are often enacted due to nuclear proliferation violations or human rights violations.

Supply - the quantity of a product that the market can offer. “Quantity” is the amount of product the producer will sell at a given price.

Tariff - the tax on goods either being imported or exported from a country

Trade - the buying or selling of goods and/or services

A fundamental of business is the law of supply and demand. In the simplest of terms, this refers to the observed relationship that as demand for a product increases, prices go up. Then as prices go up, new suppliers enter the arena and increase the supply of the product, which brings the price back to normal.

It might seem obvious that poultry producers could predict the demand for eggs or poultry meat, based on historical data and the projections made by economists. The producers could then have the flock sizes to address the demand in such a way that producing the eggs or meat would be profitable. This would generally work in a perfect world (or regulated market, such as the quota system used in Canada) where all producers cooperated and there were no unexpected changes in flock sizes. However, the United States egg industry operates in a “free market” economy. As egg prices have risen to particularly good levels, existing producers have increased their flock sizes, put surplus eggs in the market and ruined the profitable egg market.

It is also important to remember that in the United States, the cost of egg and poultry meat production is not uniform across the country. Producers far removed from the states producing the feed grains, are at a disadvantage. Those producers without in-state supplies of feed grains, pay to transport the needed corn and soybean over great distances. Conversely, egg producers from grain producing states who export eggs must add the cost of transportation to their cost of doing business.

Legislation related to the management of farm animals can also impact costs of production. On January 1, 2015 a law on Standards for Confining Farm Animals went into effect in California. The law states that each laying hen be able to extend its limbs fully and turn around freely. Following the passage of this legislation in 2008, California egg producers significantly reduced their hen numbers in order to allow for the freedom of movement dictated in the new law. This, of course, reduced the in-state supply of eggs and egg prices rose.

Unforeseen circumstances, unrelated to producer or voter decisions, can also severely impact the supply of a product. In 2015, outbreaks of Highly Pathogenic Avian Influenza (HPAI) hit the United States and were devastating to both the egg and turkey industries. Not only did in-store prices for poultry and eggs increase, changes in restaurant menus and meal times were thrown upside down. For example, some chains removed egg or poultry items from their menus, while others reduced the hours they offered a breakfast menu (read “meals with eggs”).

As our world changes and more countries grow into the category of “developing countries,” markets evolve. In general, as populations shift from rural areas to cities and as per capita income increases, so does the demand for animal protein. However, a developing country often lacks the infra-structure to immediately meet this growing demand for animal protein, including eggs and poultry meat. This can be an opportunity for the poultry industries in the United States to begin or increase their exports to those areas.

When dealing with international markets, however, the law of supply and demand is often complicated by politics. An often cited example dates back to the 1960s. In the early part of that decade, European countries put high tariffs on imported chicken. This became known as the “chicken tax.” The main target was the sale of American products in West Germany. U.S. Pres. Lyndon Johnson responded to this action by placing a tax on imported vans and trucks. His target was the importation of Volkswagens into the United States. The “chicken tax” is still around, with European tariffs on imported chicken and American taxes on imported vans.

It often appears that some governments use the opportunity of a disease outbreak in the country of a political foe, to impose a ban. In 2015 the Chinese government banned the import of all U.S. poultry and egg products, citing the detection of HPAI in the U.S. This nationwide ban was contrary to international guidelines. Fortunately, most U.S. trading partners only banned poultry and eggs imports from the regions of the U.S. where HPAI outbreaks had been confirmed.

Sometimes trade decisions are even more perplexing. In 2003, Mexico banned all poultry imports from California, citing the outbreak of Exotic Newcastle Disease in California, as the reason for the ban. California producers were outraged, for they knew full well that Newcastle Disease is endemic, or always present, in Mexico!

Due to their nutritional and food quality attributes, as well as their freedom from religious taboos, poultry and eggs will continue to be in demand around the world. How those products are traded will often depend more on politicians than on consumers.

*Francine A. Bradley, Ph.D., Extension Poultry Specialist Emerita,
University of California, Davis*

BIOSECURITY

BIOSECURITY

Biosecurity is a relatively new term that includes specific steps taken to prevent disease caused by infectious agents such as viruses, bacteria, fungi, or parasites in poultry flocks. Biosecurity includes practices that keep infectious agents off of your premises through isolation rearing and reducing disease-causing agents already on your farm through proper sanitation and disinfecting practices. Biosecurity is not just for the commercial producer of poultry, it is for ALL poultry producers.

DISEASE TRANSMISSION

Disease is the departure from health and includes any condition that impairs normal body functions. Disease results from a stress which weakens the bird and reduces the bird's resistance to infectious agents. Infectious agents — such as viruses, bacteria, fungus, or parasites that cause disease in poultry — can be introduced into a flock or transmitted by:

- Birds carrying an infectious agent within the flock;
- Recently acquired birds;
- Eggs from infected breeders;
- Human hands, hair, feet/shoes, or clothes;
- Wild birds, rodents, flies, parasites, or insects;
- Contaminated feed, water, or air;
- Contaminated vaccines and medications;
- Dust, feathers, and manure on equipment and supplies, such as trucks, coops, feeders, waterers, and egg flats.

INCREASED RISK

The risk of disease increases if a) new birds are introduced into your existing flock, b) different ages of birds are raised together, c) different types of fowl are raised together, and d) new birds are placed in contact with droppings, feathers, dust, and debris from a previous flock. Infectious agents usually only survive a short time, but if maintained in the proper environment such as cold, damp, unsanitary surroundings infectious agents can survive for a long time and travel hundreds of miles while clinging to drivers, trucks, crates, or egg flats.

The table on the back of this page lists common poultry diseases, their symptoms, and the survivability of the infectious agent which causes the disease.

ENFORCING BIOSECURITY AND DISEASE PREVENTION MEASURES

“Security” is the primary emphasis of any insurance program and this holds true for biosecurity. Security entails minimizing the number of visitors on your farm. Only authorized personnel who have been provided properly sanitized footwear, coveralls, and headgear should be allowed into your poultry houses. As caretaker, you should only visit other poultry facilities when absolutely necessary and then wear properly sanitized clothing, headgear, and footwear.

It is important to isolate new birds that are brought onto the premises before introducing them into the flock. Keep free-flying birds, waterfowl and migratory birds away from your flock. Your management should include a rodent and fly control program.

Ensure proper biosecurity by keeping only one age of bird on the premises at one time. Since small flocks generally have more than one age of bird on the premises, it is important to house different ages separately. Always take care of your young birds first, then move on to your older birds. Ideally, one should not keep various types of fowl, including pet birds, on the premises. If you keep other types of animals or birds on the premises, it is important to change coveralls, head-gear, and footwear from one animal facility to the next.

To avoid transmitting disease, thoroughly clean, wash, and disinfect any equipment such as feeders, waterers, coops, or egg flats, as well as equipment that has been on another farm, on a routine basis. Included with equipment are vehicles which come onto your farm, especially those which have been at other poultry facilities. Use only plastic coops since they are easier to wash and sanitize and do not harbor bacteria like wooden crates. Do not allow dead birds to accumulate; either compost or burn dead birds. Poultry houses should be thoroughly washed and disinfected at least once a year.

Another disease prevention measure is to have good ventilation, since large amounts of fresh air reduce infectious disease agents. Always do business with companies and other farms which enforce proper biosecurity measures. Biosecurity is a worthwhile investment for any poultry producer and it is the best insurance policy money can buy.

<i>Disease</i>	<i>Symptoms</i>	<i>Infectious agent</i>	<i>Life span away from poultry</i>
Bursal disease	Ruffled feathers, diarrhea, trembling, prostration	Virus	Months
Coccidiosis	Diarrhea, death	Protozoa	Months
Duck enteritis	Diarrhea, death	Virus	Days
Fowl cholera	Comb and face discolored and swollen	Bacteria	Weeks
Infectious coryza	Swelling around eyes and cold symptoms	Bacteria	Days
Avian influenza	Coughing, sneezing rales, lacrimation	Virus	Weeks
Laryngotracheitis	Gasping and coughing	Virus	Days
Mareks	Paralysis	Virus	Weeks
Mycoplasma	Chronic respiratory problems	Mycoplasma	Days
Salmonella	Diarrhea	Bacteria	Weeks
Avian TB	Weight loss, death	Bacteria	Years

*Michelle A. Hall, Professor Emerita,
Animal & Veterinary Science Department, Clemson University*

AVIAN INFLUENZA

Influenza is an acute contagious respiratory disease caused by a virus. Influenza can affect many animals such as horses, swine, and human beings. It is a disease with worldwide distribution and has been a costly disease to the poultry industry because of increases in production expenses which include extra feed, medication, additional care, quarantine measures, vaccines, cleaning and disinfection, decreases in carcass quality as well as losses of local and international trade.

Migratory waterfowl, imported pet birds, and live-bird markets are some of the sources of infection. Influenzas can be **zoonotic**, which means the disease can be transferred from animals to humans. Influenza is commonly referred to as the flu. The term “fowl plague” was used in the past when referring to avian influenza outbreaks resulting in high mortality. Today, an outbreak of avian influenza that results in high mortality is referred to as “highly pathogenic” avian influenza (HPAI).

Avian influenza can affect poultry (chickens, turkeys, ducks, pheasants, geese, guinea fowl, and chukars) as well as wild birds especially sea birds (sandpipers, sanderlins, ruddy turnstones, terns, swans, shearwaters, herons, guillemots, puffins and gulls). Avian influenza is caused by any Type A influenza virus belonging to the *Orthomyxoviridae* family. The disease syndromes associated with avian influenza can be **subclinical** or **mild**, meaning the bird is in the early stages of the disease and the signs of the disease are not apparent, to **acute** where the signs of the disease are severe and often lead to death. Many factors influence the outcome of infection. Some factors which determine whether the disease will be subclinical or acute are the biologic characteristics of the virus, environmental stresses, such as temperature, humidity, ventilation, crowding and the age and sex of the bird.

Avian influenza can be **transmitted** via air currents, feces, humans, vehicles, water, feed, equipment, supplies, clothes, flies, litter, beetles, and other birds dead from the disease. Transmission occurs when susceptible and infected birds are in close contact with each other or when infectious material from infected birds is introduced into the susceptible bird's environment. The virus can be excreted from the respiratory tract, conjunctiva, and feces of birds. This is known as horizontal transmission. There is no evidence to indicate avian influenza is transmitted vertically, from hen into the egg. Since the virus is readily transported by people and equipment, it is important to establish strict biosecurity measures.

Once avian influenza is transmitted, the **incubation period**, the time from when the bird first comes in contact with the disease until the first signs appear, can be a few hours to 3 days and up to 14 days. The incubation period is dependent on the dose of the virus, route of exposure, the species exposed and the ability to detect the clinical signs.

The **clinical signs** for avian influenza can vary widely depending on the species of bird affected, the age of the bird, whether the bird has another infection concurrently, the strain of virus, and environmental factors. The respiratory, reproductive, digestive, or nervous systems of the bird are affected with respiratory signs being most common. The most commonly reported signs of the disease are pronounced depression, decreased activity, decreased feed consumption and emaciation, with decreased egg production and increased broodiness in hens. Respiratory signs include coughing, sneezing, rales (abnormal respiratory sounds), excessive lacrimation (tearing) from the eyes, huddling or ruffling of feathers, along with edema (accumulation of fluid) of the head and face, cyanosis (turning blue due to lack of oxygen to the tissues) of unfeathered skin (legs, combs, wattles), nervous disorders, and diarrhea. These signs may occur alone or in any combination depending on the severity of the disease. All birds in a flock will become sick (moribund) but morbidity (death) will vary from very low to 100% depending on the strain of virus, the species affected, and other environmental factors.

To determine the **causative agent** of any disease, including avian influenza, the causative agent must be identified. In the case of avian influenza, the virus must be isolated and identified. The virus can be recovered from swabbing the trachea, and/or cloaca of live or dead birds or taking samples of every organ from dead birds. Also, blood can be taken from live birds and used to demonstrate the presence of antibodies to the avian influenza virus.

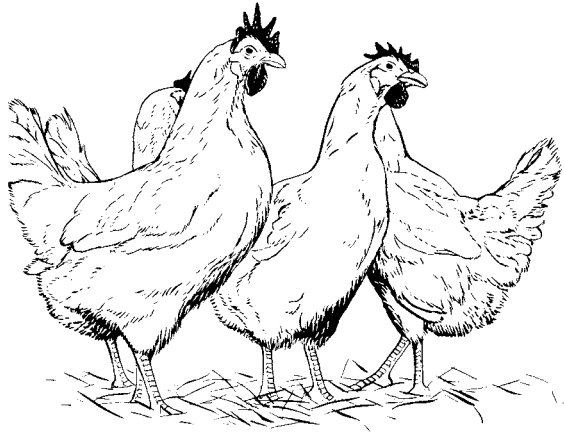
There is no practical **treatment** for avian influenza. Infected flocks must be quarantined by state animal-disease regulatory agencies and procedures recommended by the National Poultry Improvement Plan (NPIP). Quarantine continues until the flock is depopulated. All buildings should be cleaned and disinfected after the poultry have gone. Poultry litter/manure should be composted before application to cultivated lands. Any treatment for avian influenza is supportive and tries to relieve the respiratory distress. Antibiotics are not effective against viruses and are only used as supportive treatment for avian influenza to reduce the effects 'of secondary infections caused by bacteria or mycoplasmas.

Prevention is the only practical approach to avian influenza. **Biosecurity** should be the first line of defense in the prevention, and since other birds are the most likely source of infection, it is important to keep susceptible birds away from infected birds' excretions and secretions. Transmission occurs when birds are introduced to contaminated footwear, clothing, vehicles, insemination equipment, feed and water that have been exposed to avian influenza virus. The presence of the virus in fecal material is a likely means for movement by equipment and people. Another approach is serological monitoring at harvest of turkeys and chickens.

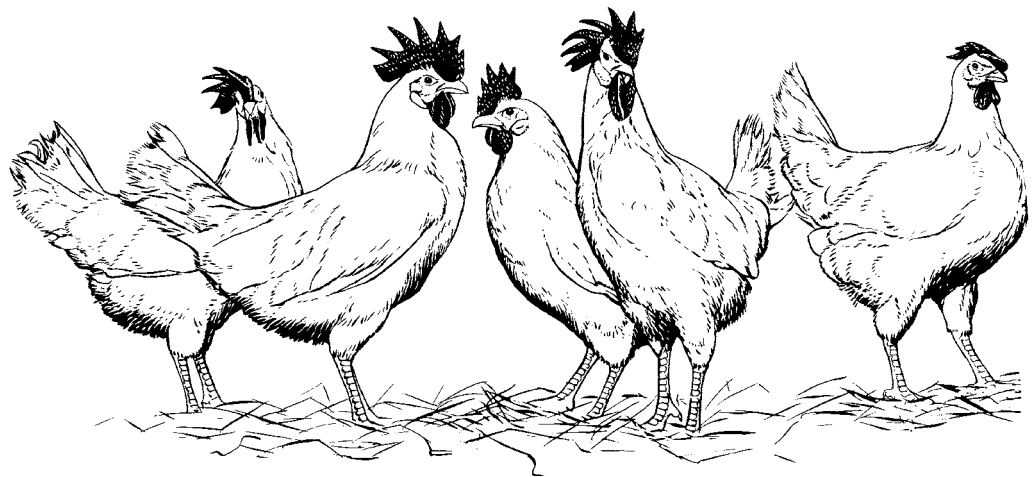
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Embryology



INTRODUCTION

Embryology is the study of the development of an individual organism. In chickens, it begins after fertilization of the egg and continues through the development of the egg until the egg hatches. This chapter is designed to help one better understand life and embryonic development. The bird egg is an excellent educational subject for the study of embryology. First, unlike most animals, the embryonic development of the bird takes place within the egg and outside of the body of the female. Second, the egg is small and readily available. Third, the incubation period is short enough to maintain interest.

HOW EGGS ARE FERTILIZED

Many people wonder how and why the embryo grows within the egg. You might wonder why eggs from the supermarket don't grow and hatch when incubated. Most of the eggs that you buy at the supermarket are from hens that are raised without a rooster being present. The male chicken — cock or rooster — makes the difference. Each sex, the cock and the hen, contributes something to the embryo. The cock provides spermatozoa. The hen provides ova. One female germ cell is called an ovum, and many are called ova. A single male germ cell is called a spermatozoon, and many are called spermatozoa. When a cock mates with a hen, it deposits spermatozoa in the oviduct. There are two sperm storage sites in the hen's reproductive tract; they are located in the vagina and the infundibulum. These spermatozoa travel the length of the oviduct to the infundibulum. On the surface of every egg yolk there can be seen a tiny, whitish spot called the blastodisc. This contains a single female cell. If spermatozoa are present when a yolk enters the infundibulum, a single spermatozoon penetrates the blastodisc, fertilizing it and the blastodisc becomes a blastoderm. Technically, the blastoderm is the true egg. Shortly after fertilization, the blastoderm begins to divide into 2, 4, 8 and more cells. The first stages of embryonic development have begun and continue until the egg is laid. Development then subsides until the egg is incubated. When a spermatozoon and an ovum unite, this process is called fertilization. After fertilization, the egg can develop and become a chick. Only fertilized eggs can grow into chicks. Once the chicks are hatched, they grow and become adult birds.

The rooster must be present for an egg to be fertilized. Roosters are not necessary at egg farms where eggs are produced for human consumption. Supermarket eggs are infertile. Eggs for incubation are produced at special farms called breeder farms where roosters are present with the hens.

THE AVIAN EGG

The avian egg is a marvel of nature's architecture. A highly complex reproductive cell, it is essentially a small center of life, a world of its own.

As we know it, the egg is the single most complete food known to humans. Versatile and nutritious, it is used every day in the preparation of the most common or the most fanciful meals.

Scientifically speaking, an egg (ovum) is the reproductive cell produced by the female. It remains a single cell until the single cell (nucleus) of the male sperm fertilizes it. Once fertilized, the egg has a full complement of chromosomes and genes to start developing.

The fertilized cell (zygote) then rapidly divides into 2 cells, 4, 8, 16, 32, 64, and so on, until the faint outline of a developing embryo and a network of blood vessels surrounding the yolk and other nutrients can be seen.

The egg is a complex structure designed to nourish and protect the embryo growing from the zygote. A vigorous, healthy chick can be hatched from each fertile egg. The egg needs a warm, humid environment while the embryo is maturing.

The Parts of the Egg

Looking at the egg from the outside we see the shell, which is a hard, protective covering composed primarily of calcium carbonate. The shell is porous and the large end contains more pores than the small end of the egg. (There are about 7,000 to 17,000 pores in a chicken egg-shell.) This permits the transfer of gases through the shell. Carbon dioxide and moisture are given off through the pores and are replaced by atmospheric gases, including oxygen.

Immediately beneath the shell are two membranes, the outer and inner shell membranes. These membranes protect the contents of the egg from bacterial invasion and prevent rapid evaporation of liquid from the egg.

The body temperature of a hen is 107 °F; therefore, eggs are very warm at the time they are laid. The temperature of the air is usually much lower than 107 °F, and the egg cools to the temperature of its surroundings. As cooling takes place, the contents of the egg contract more than does the shell of the egg. This creates a vacuum, and air is normally drawn through the pores in the large end of the shell.

As a result, an air cell forms at the large end of the egg. The air cell serves as a tiny shock absorber during early embryonic development, and on the 20th day of incubation the chick pokes its beak through the shell membranes into the air cell (which by this time has enlarged greatly) and draws its first breaths of air from this space.

While the embryo is growing, the shell membranes surround and contain the white or albumen of the egg. The albumen provides the liquid medium in which the embryo develops, but it also contains a large amount of the protein necessary for proper development.

In a fresh egg, one can see white cords attached to the yolk sac. These two cords, called chalazae, are made of twisted strands of mucin fibers, a special form of protein. The chalazae hold the yolk in the center of the egg.

The yolk contains large amounts of carbohydrates, fat, and protein. The egg white (albumen) is made of high-quality protein and water. The yolk is also a reservoir of the vitamins and minerals that are essential for normal growth. These substances, along with oxygen taken in through the pores of the shell, provide an abundant source of metabolic energy for the embryo. By-products of this process are carbon dioxide and water; the embryo uses the water and carbon dioxide is transpired through the pores of the shell. Calcium absorbed from the yolk and shell are used by the embryo to make its bone structure, or skeleton.

SCIENCE OF INCUBATION

Incubation means maintaining conditions favorable for developing and hatching fertile eggs. Still-air incubators do not provide mechanical circulation of air. Forced-air incubators are equipped with electric fans. Optimum operating temperatures differ slightly.

Four factors are of major importance in incubating eggs artificially: temperature, humidity, ventilation and turning. Of these factors, temperature is the most critical (see Table 27, below). However, humidity tends to be overlooked and causes many hatching problems. Extensive research has shown that the optimum incubator temperature is 100 °F when relative humidity is 60 percent, concentrations of oxygen 21 percent, carbon dioxide 0.5 percent and air movement past the egg is at 12 cubic feet per minute.

Table 26. Incubation Period and Incubator Operation for Eggs of Domestic Birds

Requirements	Chickens	Guinea, Peafowl, Turkey	Goose and Duck	Muscovy Duck	Pheasant	Bobwhite Quail	Coturnix Quail
Incubation period (days)	21	28	28	35	24-28	23-24	17
Still-air operating temp (F - dry bulb)	100.5	100.5	100.5	100.5	100.5	100.5	100.5
Forced-air operating temp (F - dry bulb)	99.5	99.5	99.5	99.5	99.5	99.5	99.5
Humidity (F - wet bulb)	85-87	83-85	84-86	84-86	86-88	84-86	84-86
Do not turn eggs after	day 18	day 25	day 25	day 31	day 21	day 21	day 15
Humidity during last three days of incubation (F - wet bulb)	90-94	90-94	90-94	90-94	92-95	90-94	90-94

Temperature

An incubator should be operated in a location free from drafts and direct sunlight. An incubator should be operated for 24 hours with water placed in a pan to stabilize its internal atmosphere before fertile eggs are set. During the warm-up period, the temperature should be adjusted to hold a constant 102 °F for still air, 99.5 °F for forced air. To obtain reliable readings, the bulb of the thermometer should be at the same height as the tops of the eggs and away from the source of heat. Use two thermometers to ensure you are getting an accurate reading.

Incubator temperatures should be maintained between 99 and 100 °F. High mortality is seen if the temperature drops below 96 °F or rises above 103 °F for a number of hours. If the temperature stays at either extreme for several days, the egg may not hatch. Overheating is more critical than underheating. Running the incubator at 105 °F for 15 minutes will seriously affect the embryos, but running it at 95 °F for 3 or 4 hours will only slow their metabolic rate.

Do not make the mistake of overheating the eggs. Many times, when the eggs remain clear and show no development, it is due to excessive heat during the first 48-72 hours. Do not adjust the heat upward during the first 48 hours. This practice cooks many eggs. The eggs will take time to warm to incubator temperature and many times the incubator temperature will drop below 98 °F for the first 6 to 8 hours or until the egg warms to 99 to 100 °F.

Humidity

The relative humidity of the air within an incubator for the first 18 days should be about 60 percent. During the last 3 days (the hatching period) the relative humidity should be nearer 65-70 percent. Too much moisture in the incubator prevents normal evaporation and results in a decreased hatch, but excessive moisture is seldom a problem in small incubators. Too little moisture results in excessive evaporation, causing chicks to stick to the shell.

Table 27 will enable you to calculate relative humidity using readings from a wet-bulb thermometer and the incubator thermometer.

Table 27. Relative Humidity

<u>Incubator Temperature (Dry-Bulb Readings)</u>	<u>Wet-Bulb Readings</u>					
100 °F	81.3	83.3	85.3	87.3	89.0	90.7
101 °F	82.2	84.2	86.2	88.2	90.0	91.7
102 °F	83.0	85.0	87.0	89.0	91.0	92.7
Percent Relative Humidity	45%	50%	55%	60%	65%	70%

During the hatching period, use an atomizer to spray a small amount of water into the ventilating holes to increase the humidity in the incubator. (This is especially helpful when duck or goose eggs are being hatched.)

An 8-inch pie tin or petri dish containing water placed under the tray of eggs should provide adequate moisture. The relative humidity in the incubator can also be varied by changing the size of the water pan or by putting a sponge in the pan to increase the evaporating surface area. The pan should be checked regularly while the incubator is in use to be sure that there is always an adequate amount of water.

Whenever you add water to an incubator, it should be about the same temperature as the incubator.

In the latter stages of incubation (the final three days the eggs are in the incubator), condensation on the glass indicates the presence of sufficient moisture. However, the condensation is also related to the temperature of the room where the incubator is being operated. There will be more condensation on the glass if the room is cold, so be sure the temperature in the incubator and the room remains steady.

Use a wet-bulb thermometer to determine relative humidity. The wet-bulb thermometer measures the evaporative cooling. If the wet and dry bulb read the same temperature, you would have 100 percent humidity. The greater the evaporation taking place, the lower the temperature reading on the wet-bulb thermometer and the larger the spread will be between the wet- and dry-bulb reading.

To make a wet-bulb thermometer, just add a cotton wick to the end of a thermometer. Then place the tail of the wick in water. The cotton then absorbs the water. As the water evaporates from the cotton it causes a cooling effect on the thermometer.

Ventilation

The best hatching results are obtained with normal atmospheric air, which usually contains 21 percent oxygen. It is difficult to provide too much oxygen, but a deficiency is possible. Make sure that the ventilation holes are open to allow a normal exchange of air.

Turning

Turning the eggs during the incubation period prevents the blastoderm from migrating through the albumen and sticking to the shell membrane. Chicken eggs should be turned three to five times daily from the 2nd to the 18th day. Do not turn the eggs during the last 3 days of incubation.

After the 18th day, do not open or move the incubator until the hatch is completed because the chicks are in a hatching position in the eggs and because a desirable hatching humidity must be maintained.

How the Chicken Incubates Eggs Naturally

In nature, the female chicken (hen) selects the nest site and lays a clutch of eggs (usually 8 to 13 eggs), one egg per day. Once she has a clutch of eggs, she begins sitting on the eggs full-time, leaving only for food and water.

The hen's body temperature is 107 °F. When the hen sits on the eggs, this heats the eggs to 100 to 101 °F. The hen turns the eggs on a regular basis by using her beak to scoop under the egg and roll it toward her. The humidity comes from the environment, the bird's body, and any moisture the female transfers back to the nest on her feathers. Brooding hens often leave their nests to feed at dawn or dusk when the dew is present on the grass.

Incubation Period of Other Species

One of the miracles of nature is the transformation of the egg into the chick. In a brief three weeks of incubation, a fully developed chick grows from a single cell and emerges.

Not all avian eggs hatch in 21 days. The Japanese quail needs 17 days; the pigeon 18 to 20 days. The swan and the ostrich need 42 days of incubation before hatching. The duckbill platypus is the only mammal that lays eggs, and they have an incubation period of 12 days. Never incubate the eggs of wild birds; these chicks will not live without their mother's care if they do hatch. Table 28 shows comparative incubation information for 14 domestic birds.

Table 28. Incubation Periods (species and days required to hatch)

Bobwhite Quail.....(23-24)	Guinea.....(27-28)
Canary(13)	Muscovy Duck(35)
Chicken.....(21)	Pheasants(24-28)
Chukar Partridge.....(23-24)	Pigeon.....(18-20)
Coturnix Quail.....(17)	Ostrich(42)
Ducks.....(28)	Swan.....(42)
Geese.....(28)	Turkey(28)

CHICK EMBRYO DEVELOPMENT

Where Chick Life Begins

The development of the chick begins in the single cell formed by the union of two parental cells, ovum and spermatozoon, in the process known as fertilization. In birds, fertilization occurs about 24 hours before the egg is laid.

The newly formed single cell begins to divide into 2, then 4, 8, 16, 32 and so on. At the time of laying, hundreds of cells are grouped in a small, whitish spot (the blastoderm or germinal disc) that is easily seen on the upper surface of the yolk. This spot in a fertilized, freshly laid egg is the beginning of the chick.

When the egg is laid and cools, division of the cells ceases. Cooling the egg at ordinary temperature does not result in the death of the embryo. It may resume its development after several days of rest if it is again heated by the hen or in an incubator.

Development During Incubation

As soon as the egg is heated again, the cluster of cells in the blastoderm begins to multiply by successive divisions. The first cells formed are all alike. Then, as the division of cells progresses, some differences begin to appear.

These differences become more and more pronounced. Gradually the various cells acquire specific characteristics of structure and cell grouping. These cell groupings are called the ectoderm, mesoderm and endoderm. These three layers of cells constitute the materials out of which the various organs and systems of the body are to be developed.

From the ectoderm, the skin, the feathers, beak, toes, nervous system, lens and retina of the eye, linings of the mouth, and vent are developed. The mesoderm develops into the bone, muscle, blood, and the reproductive and excretory organs. The endoderm produces the linings of the digestive tract and the secretory and respiratory organs.

Development from a single cell to a pipping chick is a continuous, orderly process. It involves many changes from apparently simple to complex structures. From these structures arise all the organs and tissues of the living chick.

Physiological Processes Within The Egg

A. Functions of the Embryonic Membranes

Many elaborate physiological processes take place during the transformation of the embryo from egg to chick. These processes are: respiration, excretion, nutrition, and protection.

For the embryo to develop without any anatomical connection to the hen's body, nature has provided membranes outside the embryo to enable the embryo to use all parts of the egg for growth and development. These "extraembryonic" membranes are the (1) yolk sac, (2) amnion, (3) chorion, and (4) allantois.

1. The yolk sac is a layer of tissue growing over the surface of the yolk. Its walls are lined with a special tissue that digests and absorbs the yolk material to provide sustenance

for the embryo. Yolk material does not pass through the yolk stalk to the embryo even though a narrow opening in the stalk is still in evidence at the end of the incubation period. As embryonic development continues, the yolk sac is engulfed within the embryo and is completely reabsorbed at hatching. At this time, enough nutritive material remains to adequately maintain the chick for up to two days.

2. The amnion is a transparent sac filled with a colorless fluid that serves as a protective cushion during embryonic development. This amniotic fluid also permits the developing embryo to exercise. The embryo is free to change its shape and position while the amniotic fluid equalizes the external pressure. Specialized muscles also develop in the amnion, which by smooth, rhythmic contractions gently agitate the amniotic fluid. The slow and gentle rocking movement apparently aids in keeping the growing parts free from one another, thereby preventing adhesions and malformations.
3. The chorion serves as a container for both the amnion and yolk sac. Initially, the chorion has no apparent function but later the allantois fuses with it to form the chorionic membrane. This brings the capillaries of the allantois into direct contact with the shell membrane, allowing calcium reabsorption from the shell.
4. The allantois has four functions: (1) It serves as an embryonic respiratory organ. (2) It receives the excretions of the embryonic kidneys. (3) It absorbs albumen, which serves as nutriment (protein) for the embryo. (4) It absorbs calcium from the shell for the structural needs of the embryo. The allantois differs from the amnion and chorion in that it arises within the body of the embryo.

B. Functions of the Embryonic Blood Vessels

During the incubation period of the chick, there are two sets of embryonic blood vessels. One set, the vitelline vessels, is concerned with carrying the yolk materials to the growing embryo. The other set, the allantoic vessels, is chiefly concerned with respiration and with carrying waste products from the embryo to the allantois. When the chick is hatched, these embryonic blood vessels cease to function.

Hatching

Several changes take place between days 18 to 21. The residual yolk sac is surrounded by the abdominal wall on the 19th and 20th days of incubation. The chick draws what remains of the yolk into its body. Fluid decreases in the amnion. The chick's head is under its right wing with the tip of the beak pointed at the air shell. The large neck muscle contracts and forces the egg tooth through the air cell, and the chick takes its first breath. This is referred to as internal pipping. At this time, you may hear the chick peeping inside the shell.

On the 21st day, the chick finishes its escape from the shell. The initial break in the shell is made by the egg tooth, a sharp, horny structure located on the tip of the upper beak. This is referred to as external pipping.

The hatching process can last 4 to 12 hours before the chick completely emerges from the shell. As the chick's head rotates from under the wing, the egg tooth pips the shell and continues to break the shell in a nearly perfect circle from the inside until it is able to push the top off the egg.

The chick, as it appears upon freeing itself from the shell, is wet and very tired. For the next several hours it will lie still and rest. A few hours later the chick, now dry and fluffy, will become extremely active.

Although used only for a single event in the life of the chick, as a tool to break through the shell, the egg tooth has served its critical purpose well. Its usefulness over, it will be lost in a few days.

DAILY EMBRYONIC DEVELOPMENT

Before Egg Laying

1. Fertilization
2. Division and growth of living cells
3. Segregation of cells into groups of special functions

Between Laying and Incubation

1. Virtually no growth. Stage of inactive embryonic life.

During Incubation

Day One:

1. Development of blastoderm.
2. Major developments visible under microscope:
 - 18 hours: Appearance of alimentary tract
 - 19 hours: Beginning of brain crease
 - 20 hours: Appearance of vertebral column
 - 21 hours: Beginning of formation of brain and nervous system
 - 22 hours: Beginning of formation of head
 - 23 hours: Appearance of blood island
 - 24 hours: Beginning of formation of eyes.

Day Two:

1. Embryo begins to turn on left side.
2. Blood vessels appear in the yolk sac.
3. Major developments visible under microscope:
 - 25 hours: Beginning of formation of veins and heart
 - 30 hours: Second, third, and fourth vesicles of brain clearly defined, as is heart, which now starts to beat
 - 35 hours: Beginning of formation of ear pits
 - 36 hours: First sign of amnion
 - 46 hours: Formation of throat

Day Three:

1. Beginning of formation of nares, wings, legs and allantois
2. Amnion completely surrounds embryo

Day Four:

1. Beginning of formation of tongue.
2. Embryo completely separate from yolk sac and turned on left side
3. Allantois breaks through amnion

Day Five:

1. Proventriculus and gizzard formed.
2. Formulation of reproductive organs - sex division

Day Six:

1. Beginning of formation of beak and egg-tooth
2. Main division of legs and wings
3. Voluntary movement begins

Day Seven:

1. Indications of digits in legs and wings.
2. Abdomen more prominent due to development of viscera.

Day Eight:

1. Beginning of formation of feathers

Day Nine:

1. Embryo begins to look bird-like
2. Mouth opening appears

Day Ten:

1. Beak starts to harden
2. Skin pores visible to naked eye
3. Digits completely separated

Day Eleven:

1. Days ten to twelve tend to run together. No different changes visible on this day.

Day Twelve:

1. Toes fully formed
2. First few visible feathers

Day Thirteen:

1. Appearance of scales and claws
2. Body fairly well covered with feathers

Day Fourteen:

1. Embryo turns its head toward blunt end of egg

Day Fifteen:

1. Small intestines taken into body

Day Sixteen:

1. Scales, claws and beak becoming firm and horny
2. Embryo fully covered with feathers
3. Albumen nearly gone and yolk increasingly important as nutrient

Day Seventeen:

1. Beak turns toward air cell, amniotic fluid decreases and embryo begins preparation for hatching

Day Eighteen:

1. Growth of embryo nearly complete

Day Nineteen:

1. Yolk sac draws into body cavity through umbilicus
2. Embryo occupies most of space within egg except air cell

Day Twenty:

1. Yolk sac completely draws into body cavity
2. Embryo becomes chick, breaks amnion, starts breathing air in air cell
3. Allantois ceases to function and starts to dry up

Day Twenty-one:

1. CHICK HATCHES

OBSERVING THE DEVELOPING EMBRYO

Candling

The development of the embryo can be observed by candling. Candling is done by holding a bright light on the large end of the egg in a darkened room and looking at the inside. "Candling" got its name from using a candle to look at the inside of the egg.

Candling serves three important functions. First, candling the egg before it is set will eliminate any cracked eggs from being set. Cracked eggs will not hatch. Second, candling helps determine which eggs are fertile. Third, by candling the eggs every few days you can observe the growth and development of the embryo without breaking the egg open.

ONCE THE CHICKS HATCH

Brooding

Whether there is one chick or 1,000 chicks in the brooding unit, the principles are the same. The chicks must be kept warm, well fed, watered, protected from predators and dampness and provided with plenty of fresh air without being exposed to drafts.

Newly hatched chicks can live on the unabsorbed yolk in their bodies for about 2 days if necessary. However, chicks with access to feed and water will begin to eat and drink when less than one day of age.

It is extremely important that you build and/or setup all necessary equipment at least two days prior to the chicks hatching.

Brooders should maintain a temperature of 95 °F (taken at one inch above the floor level, the height of the chick's back) during the first week, then decrease the temperature 5 °F per week until room temperature is reached.

The brooder should have a textured, absorbent litter on the floor. If the floor is slippery, the chicks can damage their legs.

Feed 18 to 22 percent protein chicken starter food. The feed can be placed in jar lids, egg cartons, small cans or a commercial chick feeder, any item which can hold enough feed to keep feed available at all times.

Water should be available at all times. Use watering equipment which prevents the chick from getting into it and drowning. Commercially made water fountains can be bought and added to a quart jar.

Clean the waterer and brooder daily. This will prevent odors and keep the brooder dry. Dampness provides favorable conditions for the development of molds and bacteria. Providing at least 1 square foot for every five chicks will also help keep the conditions more desirable.

GLOSSARY

albumen - a combination of the four layers of a whitish watery substance with protein that surrounds and contains the yolk within the center of the egg shell.

allantois - an organ in the embryo of birds which functions as a respiratory organ in the developing embryo. Its blood vessels transport oxygen to the embryo and carry away the carbon dioxide.

amnion - a thin, membranous, fluid-filled sac surrounding the embryo.

avian - of, or pertaining to, Aves or birds.

bacteria - microscopic single-celled organisms.

blastoderm - the collective mass of cells produced by the splitting of a fertilized ovum from which the embryo develops.

blastodisc - the germinal spot on the ovum from which the blastoderm develops after the ovum is fertilized by the sperm.

brood - (*n.*) baby chicks hatched from one nest (setting) of eggs.
- (*v.*) care for baby chicks.

candling - observing the shell and the contents of the egg (blood vessels, embryonic development, blood or meat spots, air cell, etc.) through the shell by holding the egg up to a bright light that is focused on and behind the egg shell.

cell - a mass of protoplasm (usually microscopic) within a semi-permeable membrane, containing a nucleus, and capable of functioning as an independent unit.

chalazae - prolongations of the thick inner-white that are twisted like ropes at each end of the yolk. Their function is to anchor the yolk in the center of the egg shell cavity.

chorion - a membrane enveloping the embryo, external to and enclosing the amnion.

chromosomes - a series of paired bodies in the nucleus, constant in number in any one kind of plant or animal.

cloaca - in birds, the common chamber into which the intestinal, urinary and reproductive tract come together.

dorsal - of, on or near the back.

dry-bulb thermometer - expresses a temperature reading in number of degrees Fahrenheit (F) or centigrade/Celsius (C).

egg (avian) - the female reproductive cell (ovum) surrounded by a protective calcium shell and, if fertilized by the male reproductive cell (sperm) and properly incubated, capable of developing into a new individual.

egg tooth - The temporary horny cap on the chick's upper beak which serves for pipping (breaking through) the shell. Usually dries and falls off within 18 hours after chick hatches.

embryo - a fertilized egg at any stage of development prior to hatching. In its later stages, it clearly resembles the fully developed chick.

embryology - the study of the formation and development of plant and animal embryos.

evaporation - changing of moisture (liquid) into vapor (gas).

fat - organic combination of carbon, hydrogen, and oxygen in such relative quantities that the caloric value of the compound is high.

fertile - capable of reproducing.

fertilized - an ovum impregnated by a sperm.

follicle (ovarian) - the thin membrane of the ovary which encloses the developing yolk; the yolk sac.

gene - an element in the chromosome of the germ plasm that transmits hereditary characteristics.

hatching egg - a fertilized egg, one with the potential of maturing.

humidity - see "relative humidity".

incubate - to maintain favorable conditions for developing and hatching fertile eggs.

incubator - a container with the proper humidity and temperature to allow fertile eggs to hatch.

infundibulum - any of various hollow, conical organs or parts thereof.

membrane - a thin, soft, pliable sheet or layer of tissue covering an organ.

nutrient - food that contains substances necessary to sustain life and growth.

ovary - the female reproductive gland in which eggs are formed.

oviduct - the tube through which eggs pass after leaving the ovary.

ovum - the female reproductive cell.

papilla - any small, pimple-like or teat-like projection.

peristaltic action - involuntary movement of the muscles of the oviduct that forces the egg onward.

pip - a baby chick breaking from its shell.

pores - thousands of minute opening in the shell of an egg through which gases are exchanged.

protein - one of a group of nitrogenous compounds commonly known as amino acids.

pituitary - a small, oval, two-lobed vascular body attached to the infundibulum of the brain that secretes hormones affecting growth.

relative humidity - the amount of moisture in the air compared with the amount that the air could contain at specific temperatures. Expressed as a percentage.

semen - secretion of the reproductive organs of the male; composed of spermatozoa, epithelial cells, secretions of seminal vesicle.

spermatozoa (pl.) - mature male germ cells, the specific output of the testes.

spermatozoon - male reproductive cell.

still-air incubator - a container for hatching chicks that does not have mechanical ventilation.

system - functioning unit of the anatomy, such as the skeletal, muscular, glandular, respiratory and digestive systems.

testes - the male genital glands (plural).

testicle, testis - the male genital gland (singular).

vitamin - a fat- or water-soluble substance necessary, in very small amounts, to allow for normal growth and maintenance of life.

vitelline - of, pertaining to, or like, the yolk of an egg.

wet-bulb thermometer - a device to measure the amount of moisture or water vapor in the air.

yolk - a globular mass of yellow, nutritious semi-liquid contained in a transparent membrane (the vitelline membrane) and located in the center of an egg. The yolk is the chick's food during its pre-hatching life and its first food after it emerges from the shell.

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