Chapter 10
Eggs and Egg Products

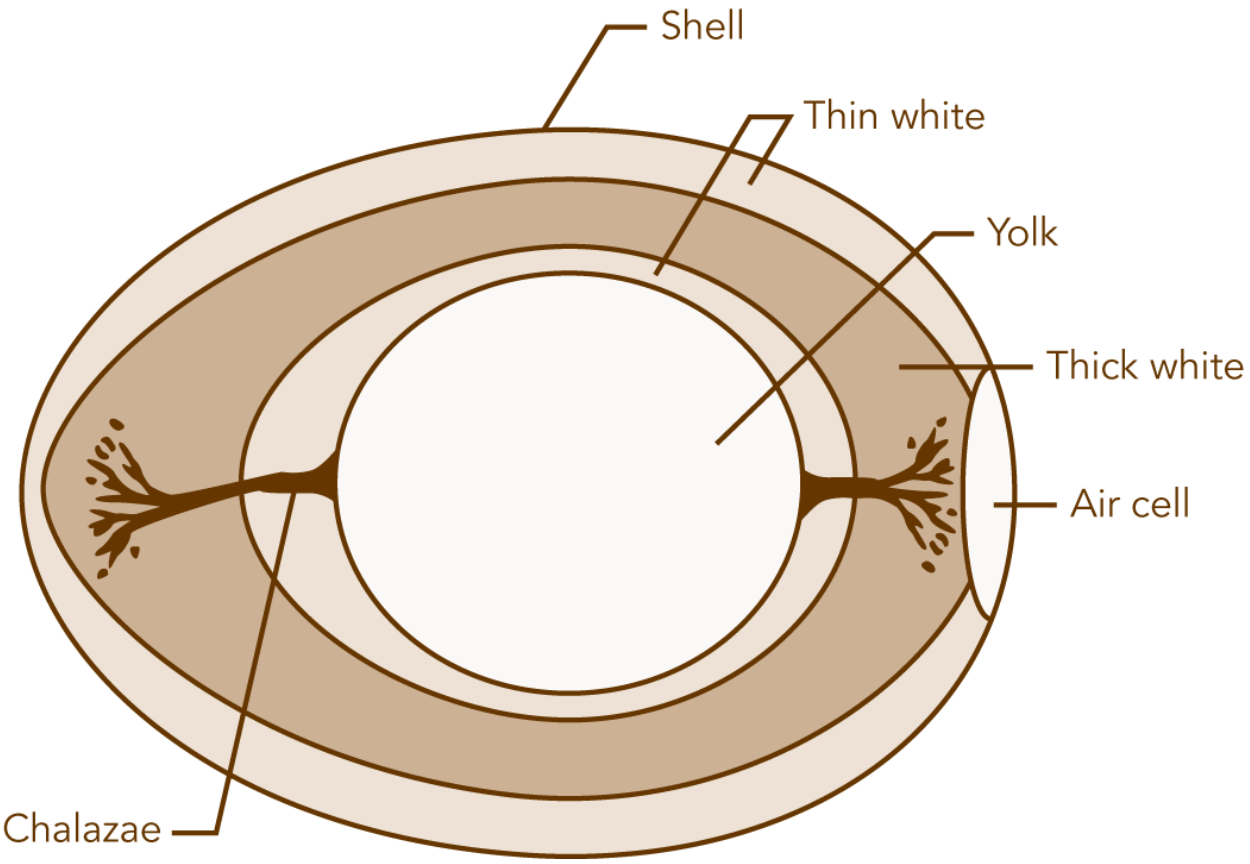
How Baking Works

Words, Phrases, and Concepts

- Albumen
- Ovomucin
- Lipoproteins
- Lecithin
- Chalazae
- Shell eggs
- Egg grades
- Egg products
- Whole-egg substitute
- Denature
- Coagulation/aggregation
- Curdling
- Salmonella
- Salmonella poisoning

Makeup of an Egg

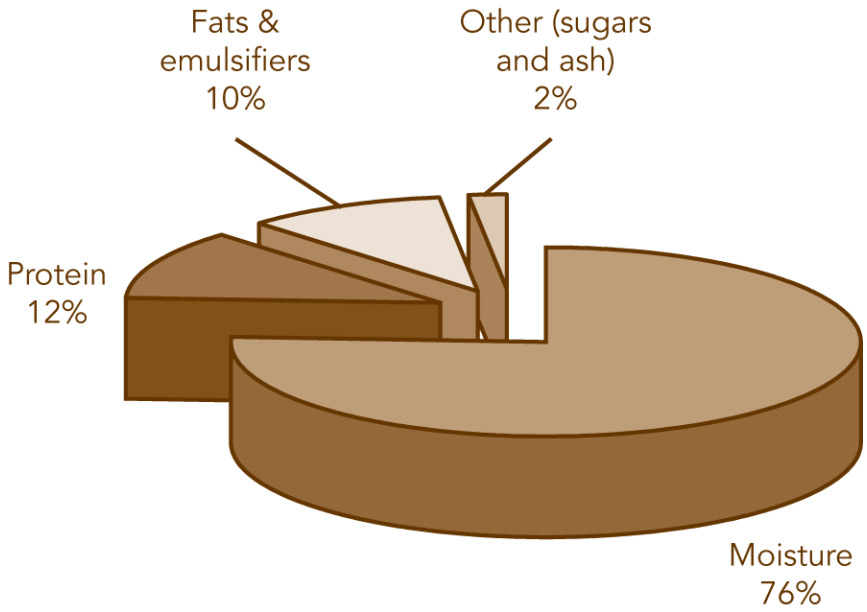
Egg has six distinct parts.



Makeup of an Egg

Is mostly moisture. Also contains:

- Protein.
- Fat and emulsifiers.
- Other (sugars, minerals/ash, etc.).



Makeup of an Egg

Components are unevenly distributed between white and yolk.

TABLE 10.1 THE MAKEUP OF WHOLE EGGS, EGG WHITES, AND EGG YOLKS

COMPONENT	WHOLE	WHITE	YOLK
Moisture	76%	88%	50%
Protein	12%	10%	17%
Fat and emulsifiers	10%	0%	30%
Other (sugars and ash)	2%	2%	3%

Which part of the egg is mostly moisture (water)?
Which part contains fat and emulsifiers?
Which part is higher in protein?

Makeup of an Egg

Egg white

- Also called egg albumen.
- Makes up about two-thirds of edible part of egg.
- Contains an important mix of proteins vital to its functions in baked goods, including:
  - Structure
  - Aeration
- Has thick and thin portions.
  - Thickened by ovomucin, a very large protein.
- Thins as it ages, losing its ability to whip into a stable foam.
  - Ovomucin breaks down and dissolves as egg ages.

Makeup of an Egg

Egg yolk

- Makes up about one-third of edible part of egg.
- Yolk proteins are called lipoproteins.
  - Proteins bound to lipids (fats and emulsifiers).
- Is an emulsion of lipoproteins and fat droplets suspended in liquid.
- As it ages:
  - Yolk thins out.
  - Protective yolk membrane weakens.
  - Is difficult to separate from the white.

Makeup of an Egg

Egg yolk (cont.)

- Very high in lecithin and other emulsifiers.
  - About 10 percent lecithin, by weight.
  - Emulsifiers (and lipoproteins) bond to both water and oil, holding them together as an emulsion.
    - Example: cake batter.

Emulsion, left, appears white because of how light bounces off microscopically small droplets of oil dispersed throughout.

Makeup of an Egg

Egg yolk (cont.)

- Picks up flavor, color, and nutrients of hen's feed.
  - Colored by yellow-orange carotenoid pigments in feed.
    - Alfalfa and yellow corn produce deeply colored yolks.
    - Wheat, oat, and white corn product lighter yolks.
    - Marigold petals can be added for additional color.
  - Healthful omega-3 fatty acids sometimes added to feed.

Makeup of an Egg

Shell

- Hard, yet porous.
  - Odors can penetrate.
  - Moisture and gases can escape.
- Washed and sanitized before eggs packed in cartons.
- Breed of hen controls eggshell color.
  - Color has no effect on flavor, nutrition, or functionality of egg.

Makeup of an Egg

Air pocket

- Air pocket forms at the egg's larger end.
- Increases in size as egg shrinks with age.
  - Causes older eggs to float in water.

Chalazae

- Twisted white cords.
  - Anchor the yolk to the center of the egg.
- An extension of the egg white; similar to ovomucin.
  - Edible, but use a sieve or chinois to strain out, if desired
- Especially prominent in fresh eggs; disintegrates with age.

Commercial Classification of Shell Eggs

Shell eggs

- Eggs purchased in the shell.
- Also called fresh eggs, but may not be “fresh.”
  - Could be several weeks old before purchased.
- Classified by both size and grade (quality).

Egg size classifications

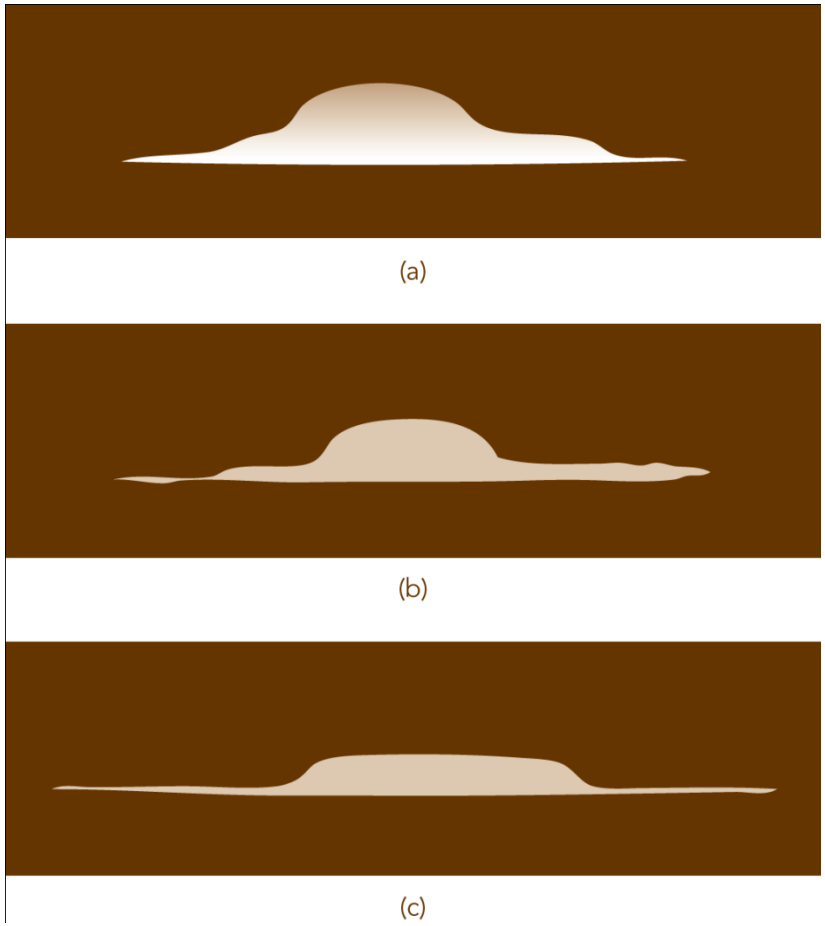
- Six size classifications.
  - Most common classifications: large, extra large, jumbo.
- In U.S., based on minimum weight of a dozen eggs.
  - Individual eggs within a dozen can vary.

Commercial Classification of Shell Eggs

Egg grade classifications

- Does not reflect safety or nutritional quality.
- U.S. and Canadian grading systems are similar but not identical.
- Higher-grade eggs have
  - Firmer whites and yolks.
  - Smaller air cells.
  - Intact and prominent chalazae.
  - Uniformly shaped and colored shells.
- All grades of shell eggs – grades AA, A, and B – are appropriate for general baking.

Commercial Classification of Shell Eggs



Egg grades: **(a)** Grade AA **(b)** Grade A **(c)** Grade B

- Grade AA eggs hold their shape best, especially important when frying or poaching, less important when baking.

Commercial Classification of Shell Eggs

Eggs are graded when they are packed.

- Generally occurs within a day or so of being laid.
  - Can occur up to 30 days after eggs are laid.
  - Pack date must be displayed as the Julian date.
    - 001 represents Jan 1 while 365 represents Dec 31.
  - Can also have a sell-by or use-by date displayed on carton.
- Grade does not necessarily reflect freshness of egg.
  - Freshly-laid eggs can vary in quality (grade).
- Grade does decrease with age, however.
  - Eggs can drop from grade A to B in about 5 weeks.
  - If improperly stored, grade can drop in a matter of days.

Egg Products

Egg products are eggs sold removed from their shells.

- Can be:
  - Refrigerated.
  - Frozen.
  - Dried.
- Includes:
  - Whole eggs.
  - Egg whites.
  - Egg yolks.
- Used in place of shell eggs for most applications.

Egg Products

There are many advantages to egg products.

- Main advantage: safety.
  - Egg products have been pasteurized, by law.
    - Are free of salmonella bacteria.
  - Can be used in uncooked sorbets, icings, etc.

TABLE 10.2 MAIN ADVANTAGES OF EGG PRODUCTS

Safety, because by law, they must be pasteurized
Time saved in cracking and separating eggs; potentially reduced labor costs
Space saving (storage)
No loss due to breakage
Longer shelf life, as long as products remain dry or frozen
No leftover whites or yolks from separating shell eggs
Uniformity in quality

Egg Products

Frozen whites

- Can be used in most applications requiring egg whites, including whipping.
  - Often contain
    - Guar gum, to thicken and to protect from ice crystal damage.
    - Whipping agents, such as triethyl citrate.
  - May not whip properly in Swiss meringues.
- Thick and thin whites separate out from freezing.
  - Shake or stir thawed whites before use.

Egg Products

Frozen sugared yolks

- Contain 10 percent sugar or glucose corn syrup.
  - Minimizes gelling of proteins to thick gummy solid.
- For formulas that are high in egg yolks, adjust for the amount of sugar in frozen sugared yolks.

  Example: for 1 pound (1 kilogram) of yolks, use 1.1 pounds (kilograms) of sugared yolks; reduce sugar in formula by 0.1 pounds (100 grams), or about 1.5 ounces.

Egg Products

Refrigerated liquid yolks

- Unlike frozen yolks, no added sweetener.
- Do not freeze yolks sold for refrigerated storage.
  - Excessive gelling in freezer reduces the ability of yolks to aerate, emulsify, and mix well with other ingredients.

Frozen whole eggs

- Contain whites and yolks in their natural proportion.
- Will thicken somewhat when frozen.
- Often contain a small amount of added citric acid.
  - Prevents gray-green discoloration that can occur when whole eggs are heated.

Egg Products

Liquid whole-egg substitute

- Made from egg whites.
  - Fat-free and cholesterol-free.
  - Contains small amounts of beta carotene, for yellow color.
  - May contain other optional ingredients, including dry milk solids, vitamins and minerals, gums, salt, and seasonings.
    - Read label before using in baked goods; some contain onion and garlic, for use in scrambled eggs and omelets.
- For baked goods, consider using egg whites instead.

Egg Products

Dried whole eggs

- Not common in bakeshops, but are perfectly acceptable for muffins, breads, cookies, most cakes.

Dried yolks

- Sometimes contain added sugar, to protect lipoproteins from damage during drying.

Dried egg whites

- Improved whipping ability over liquid egg whites.
  - Increases body and stability when added to meringue.
- Use instead of liquid eggs in royal icing, an uncooked decorating icing that dries to a hard, glossy finish.

Functions of Eggs

- Providing structure.
  - Coagulating proteins in both whites and yolks provide structure.
    - Yolks often provide less structure, because they also contain tenderizers.

Functions of Sweeteners

- Aerating.
  - Egg whites, egg yolks, and whole eggs all aerate, producing a stable foam.
- Emulsifying.
  - Egg yolks keep oil and water from separating.
    - Lipoproteins and emulsifiers bond to both oil and water, holding them together.
    - Important for binding ingredients in batters and doughs.
  - Eggs often added to creamed butter or shortening.
    - So mixture does not break, warm eggs to room temperature first and add slowly.

Functions of Sweeteners

- Contributing flavor.
  - Rich egg flavor comes mostly from egg yolk.
    - Yolk is high in fat, which contributes to richness.
- Contributing color.
  - From yellow-orange carotenoids in yolk.
  - Proteins in white and yolk contribute to brown color from Maillard browning.

    Caution: aluminum bowls, beaters, and saucepans can discolor egg mixtures to a dull gray.

Functions of Sweeteners

- Adding nutritional value.
  - Egg proteins are of the highest nutritional quality.
  - Yolk contains essentially all of the vitamins and minerals.
  - Many health authorities still recommend limiting consumption of yolks.
    - Yolks contains fat (mostly unsaturated) and cholesterol.
  - Yellow-orange carotenoids are antioxidants, important to health.
    - Lutein reduces risk of severe vision loss in older people.

Functions of Sweeteners

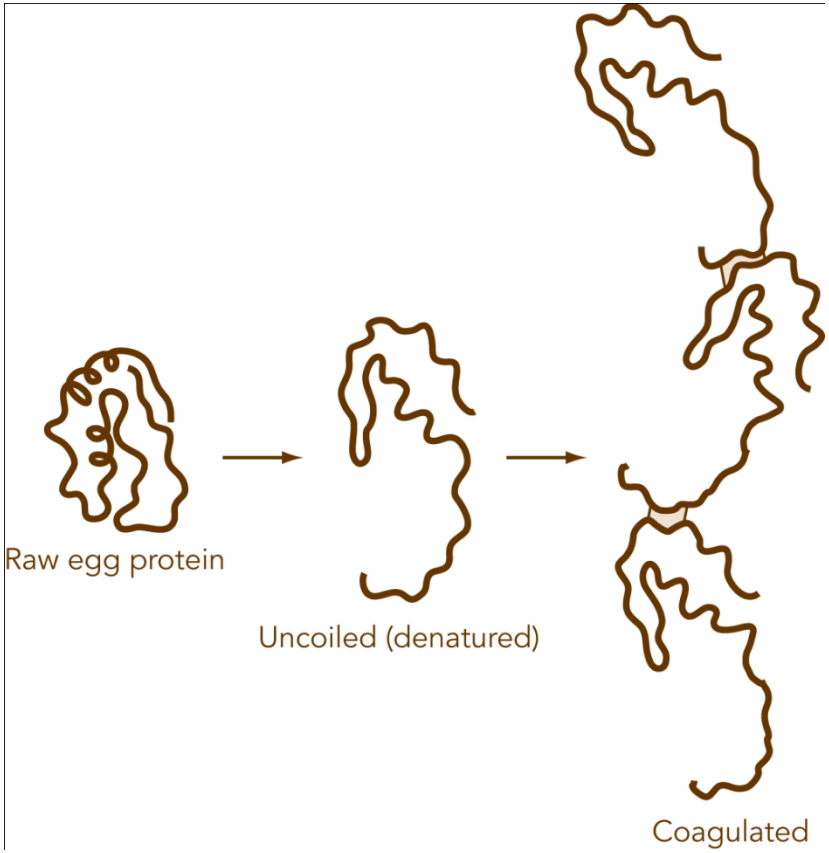
- Additional functions
  - Preventing staling.
  - Adding shine to the surface of baked goods.
  - Serving as an edible glue.
  - Promoting smoothness in icings, confections, and frozen desserts.
  - Adding moisture.
  - Increasing softness in raw dough.

Process of Egg Coagulation

Egg coagulation

- Occurs when heat causes egg proteins to
  - Denature, or unfold, then
  - Bond, or aggregate, forming clusters.
    - Forms a strong yet flexible three-dimensional network.
    - Traps water and other liquids.
- Coagulation also occurs with
  - Acid
  - Salt
  - Freezing
  - Whipping
  - Drying

Process of Egg Coagulation



Denatured egg proteins bond, or aggregate, forming an extensive three-dimensional network of clusters of egg proteins.

Process of Egg Coagulation

The more eggs are heated, the more egg proteins aggregate.

- Protein network becomes tighter, firmer, more rigid.
- Eventually, eggs curdle, or overcoagulate.
  - Custards shrink and become rubbery; water squeezes out.
  - Baked goods shrink, become tough and dry.
- In general, it is best to slow down coagulation.
  - That is, it is best to raise the temperature of coagulation.
  - This makes it easier to control coagulation and to reduce risk of overcoagulation and curdling.

Egg Coagulation

To slow coagulation of eggs:

- Dilute the eggs with water, milk, or another liquid.
  - Why this works: Reduces likelihood of egg proteins bumping and bonding.

    Example: custard sauce coagulates properly at about 180°–185°F (82°–85°C) while undiluted eggs coagulate properly by about 160°F (70°C).
- Slow the rate of cooking.
  - Lower oven temperature, use water bath, or use double boiler, if necessary.
  - Why this works: Prevents not only fast but also uneven coagulation.
  - Besides preventing curdling, the result is more even thickening and gelling.

Egg Coagulation

To slow coagulation of eggs: (cont.)

- Use egg yolks rather than egg whites.
  - Why this works: The fats and emulsifiers in egg yolks make it more difficult for the lipoproteins to coagulate.

    Note: the lower moisture in egg yolks sometimes counteracts this effect, if water is not adjusted in formula.
- Add sugar.
  - Why this works: Slows the unfolding of egg proteins.
- Add fats, oils, and emulsifiers.
  - Why this works: Interacts with egg proteins, interfering with coagulation.
- Reduce the amount of acid.
  - Acids include lemon juice, cultured dairy products, fruits.

Egg Coagulation

To slow coagulation of eggs: (cont.)

- Add starch.
  - Why this works: Starch interferes with egg coagulation, probably by competing for water and by physically getting in the way.

    Example: Pastry cream, with its added cornstarch or flour, is boiled, without risk of eggs curdling.

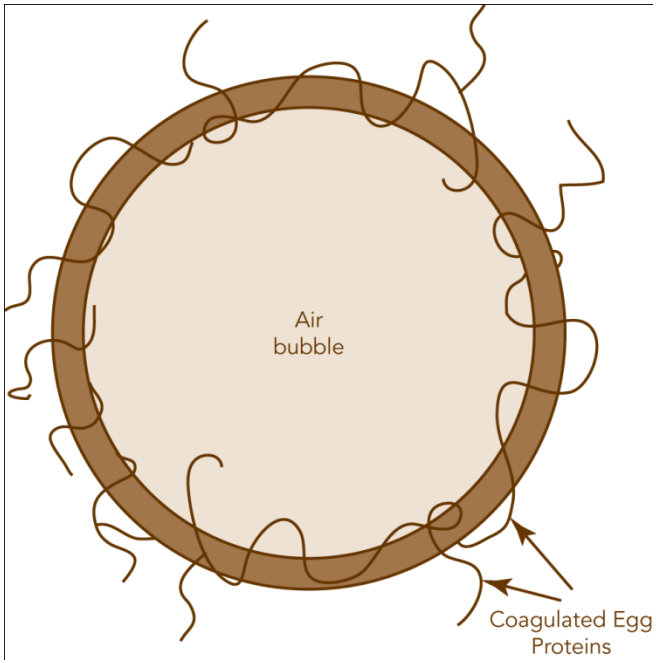
Other factors that affect egg coagulation:

- Hard water and table salt speed up and strengthen egg coagulation.
- Dairy proteins interact with egg proteins, firming up custards.
- Protease enzymes in raw pineapple, for example, breaks down egg proteins, preventing them from coagulating.
- Stirring eggs as they are heated softens their set.

Process of Egg Foam Formation

As eggs are whipped:

- Air bubbles are beaten into the liquid.
- Egg proteins denature, or unfold.
  - Denatured proteins aggregate (bond) around the surface of the bubbles, surrounding them with a strong, flexible film.



Meringue Stability

Meringue is egg white whipped with sugar.

- Uses:
  - For lightness and volume in
    - Mousses.
    - Souffles.
    - Angel food and sponge cakes.
    - Icings.
  - Baked into
    - Macaroons.
    - Cake layers (dacquoise)
    - Tartlet shells.
- Stable meringue is firm yet flexible.
  - Holds up to folding, piping, baking.
  - The more stable the meringue, the denser, less tender it is.

Meringue Stability

To increase stability of whipped egg white:

- Add sugar; the more sugar, the more stable the foam.
  - Why this works:
    - Slows the unfolding and aggregation of proteins.
    - Thickens the liquid film that surrounds the air bubbles.
  - Be sure to add slowly.
  - Add up to two times the weight of egg white.
- Use a clean bowl, and be sure no egg yolk is in with whites.
  - Why this works: Lipids surround air bubbles in a foam, but they cannot form a film structure; bubbles collapse.
- Add a small amount of acid.
  - Add cream of tartar, or wipe bowl with lemon.
  - Why this works: Lowers pH, allowing for a more flexible protein film to form.

Storage and Handling

Eggs are a potentially hazardous food.

- Salmonella bacteria can contaminate eggs and cause illness.
  - Salmonella poisoning, also called salmonellosis, causes intestinal distress.
  - Symptoms are diarrhea, vomiting, fever, intense abdominal pain.
  - Sometimes severe enough to require hospitalization; can lead to death.
- Properly storing and cooking eggs are important means for assuring food safety.

Storage and Handling

Receiving and storing eggs

- Check temperature of shipment of shell eggs.
  - Should be 45°F (7°C) or below.
- Evaluate one or two eggs for freshness.
  - Check for cleanliness of shell, thickness of white and yolk, odor.
- Refrigerate eggs immediately.
  - Store shell eggs in their original containers.
- Refrigerate or freeze liquid egg products immediately.
  - Unopened refrigerated egg products can be held for up to 12 weeks.
  - Once opened, use within a few days.

Storage and Handling

Proper egg usage

- Discard cracked eggs, or those with a strong off odor.
- Do not wash eggs before use.
- Do not crack and pool large amounts of egg for later use.
  - Eggs out of their shell are susceptible to bacterial growth.
- Crack an egg into a small bowl; inspect for shell pieces before use.
  - Do not crack eggs directly into a bowl of ingredients.
- When breaking eggs, do not allow shell to come into contact with egg contents.
  - Use a clean utensil and not an eggshell to remove bits of shell from cracked eggs.

Storage and Handling

Proper egg usage (cont.)

- Avoid cross contamination.
  - Sanitize equipment, utensils, countertops after exposure to eggs.
  - Wash hands thoroughly after handling raw eggs.
- Cook shell eggs for a minimum of 3.5 minutes at 140°F (60°C).
- Use pasteurized egg products in uncooked products.
- Cool cooked products, such as custard sauce, quickly in an ice water bath; refrigerate at or below 40°F (4°C).

Storage and Handling

To thaw frozen egg products:

- Thaw overnight under refrigeration, or
- Place unopened container under cold running water.
- *Caution*:
  - Do not thaw at room temperature.
  - Do not thaw under hot water.

Storage and Handling

Dried eggs

- Store at room temperature, in a cool, dry place.
- To use:
  - Blend with other dry ingredients.
    - Increase water in formula accordingly.
  - Reconstitute with cool water and allow time for eggs to hydrate before use.
    - Once reconstituted, treat as any liquid egg and refrigerate.