Meat Science & Food Safety

"THE" approved resource for the National FFA Meats Evaluation & Technology CDE written exam

REVISED JUNE 2019

Slides with Revisions (2019)

- Include:
  - 17, 22, 24, 32, 39, 48, 49, 65, 68, 69, 75, 77, 80, 86, 98, 99, 104, 105, 108, 109, 110, 112, 127, 128, 156, 163, 164, 173, 177, 181, 182, 188 and 191

Objectives

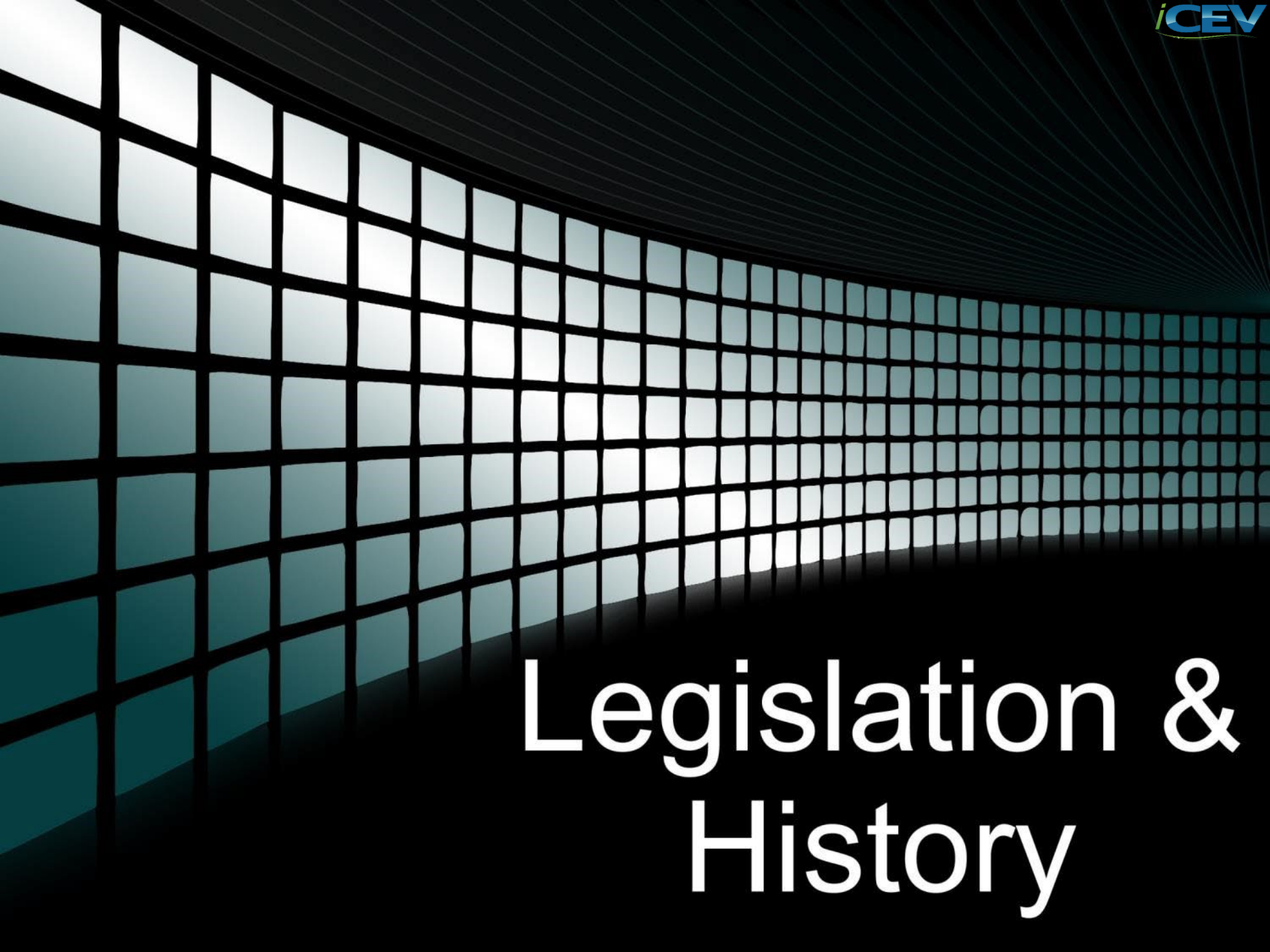
- To explore legislation and history in relation to the meats industry.
- To study animal care and handling techniques.
- To identify the nutritional content and benefits of meat.
- To consider consumer options when purchasing meat.

Objectives

- To describe meat storage and handling practices.
- To understand meat cooking methods.
- To study meat additives and processed meats.
- To analyze food safety practices and causes of foodborne illnesses.

Main Menu

- Legislation & History
- Animal Care & Handling
- Meat Nutrition
- Purchasing Meat
- Meat Storage & Handling
  - Meat Storage
  - Meat Handling
- Meat Cookery
- Processed Meats
  - Processed Meats
  - Additives
- Food Safety


iCEV
Legislation &
History

The Meats Industry

- Has a long history in the United States
  - the first longhorn cattle were brought to the Americas by the Spaniards in the 1490s
- Is constantly increasing its knowledge related to food safety
- Is regulated on a federal level by legislative action

Legislation

- Implemented the federal and state regulation of antemortem and postmortem inspection of meat animals
- Established approved harvesting procedures of animals, with some exceptions allowed for religious slaughter
- Sets critical levels for bacteria and illness

Important Legislation

- Includes:
  - Meat Inspection Act, 1906
  - Pure Food and Drug Act, 1906
  - Packers and Stockyards Act, 1921
  - Humane Slaughter Act, 1958
  - Wholesome Meat Act, 1967
  - Humane Methods of Slaughter Act, 1978

The Meat Inspection Act

- Was enacted on June 30, 1906, to prevent the adulteration and misbranding of meat products
- Was prompted by the publishing of *The Jungle* by Upton Sinclair
  - exposed the conditions of immigrants working in the U.S.
  - brought attention to conditions in meat processing plants

The Meat Inspection Act

- Had four main impacts on the industry:
  - antemortem inspection of all livestock before slaughter
  - postmortem inspection of every carcass
  - sanitary conditions in all meat processing facilities
  - authorized the United States Department of Agriculture (USDA) to monitor and inspect all harvesting and processing operations

The Pure Food & Drug Act

- Was enacted the same day as the Meat Inspection Act
- Provided for federal inspection of all meat products
- Prohibits the sale, manufacture and transportation of adulterated food products
- Paved the way for the creation of the Food and Drug Administration (FDA)

The Packers & Stockyards Act

- Was enacted on June 15, 1921
- Gave the Secretary of Agriculture and the USDA authorization to regulate livestock marketing and meat packing
  - monitoring of scales and brands
- Has been amended five times:
  - 1958, 1976, 1987, 2000 and 2002

The Humane Slaughter Act

- Was originally passed in 1958
- Was required for animals whose meat would be sold to federal agencies
- Applied to only cattle, horses, mules, sheep and swine
- Has been amended and the law, now enforced by the Food Safety and Inspection Service (FSIS), was passed in 1978

The Wholesome Meat Act

- Was the amendment to the Meat Inspection Act of 1906
- Was passed in 1967
- Requires state inspection of processing facilities to equal or exceed federal inspection standards

The Wholesome Meat Act

- Requires a federal, USDA or state inspection mark
  - mark can be found on the can, package and/or primal cuts of meat
- Assures meat is from healthy animals, harvested and processed under sanitary conditions

Meat Moment: The federal or state inspection mark indicates wholesomeness and safety, not quality.

Uniform Retail Meat Identity Standards

- Was implemented by the meats industry in 1973
- Established a single, specific name for each basic retail cut
- Increased the amount of information found on the label of a meat package
- Is a voluntary program

The Humane Methods of Slaughter Act

- Amended the Humane Slaughter Act
- Was passed in 1978
- Clearly outlines handling, stunning and harvesting procedures
- Lists the approved stunning methods
  - captive bolt stunner
  - electric shock
  - carbon dioxide gas

The Humane Methods of Slaughter Act

- Allows exceptions for ritual slaughtering practices
  - Halal: method of slaughter, meat processing and handling according to Islamic dietary laws in accordance with the Quran
  - Kosher: method of slaughter, meat processing and handling according to the Jewish dietary laws in accordance with the Torah

Meat Moment: Halal is Arabic for “permitted” or “lawful.” Kosher is Hebrew for “properly prepared.”

The Hazard Analysis Critical Control Point Approach to Food Safety

- Is most commonly referred to as HACCP
- Was first implemented in the 1950s by the Pillsbury Company® in the manufacturing of food for NASA astronauts
- Is a process of identifying possible sources of food adulteration during processing
- Must be in place in all federal and state inspected meat and food processing facilities in the U.S.

The Nutritional Labeling & Education Act

- Was passed in 1990
- Required nutritional information labels on all food products except single ingredient foods, such as fresh meat
  - nutritional labels were voluntary until 1990

The Nutritional Labeling & Education Act

- Requires the following information on a nutritional label:
  - serving size
  - number of servings per container
  - number of calories per serving
  - number of calories from total fat and saturated fat
  - amount of total fat, saturated fat, cholesterol, sodium, total carbohydrates, complex carbohydrates, sugars, total proteins and dietary fiber per serving
  - vitamins, minerals or other nutrients

The Nutritional Labeling & Education Act

- Was amended to require the nutritional labeling of single ingredient meat products in 2011
  - labeling began in January 2012

Other Important Dates in Meat Science & Food Safety

- 1993: The first *Escherichia coli* 0157:H7 outbreak is traced to ground beef from the major fast food chain Jack in the Box®; the USDA requires meat processors to test for this pathogen and considers it an adulterant in ground beef
- 1994: FSIS releases the Safe Food Handling label; required on all raw meat products
- 1997: The FDA Modernization Act implements the broadest changes to the foods industry since 1938

Other Important Dates in Meat Science & Food Safety

- 2002: The FDA requires nutritional labels to include trans-fat content
- 2011: The USDA announces plans to require mandatory testing for six more serogroups of *E. coli* in addition to 0157:H7 including: O26, O103, O45, O111, O121, and O145

Safety Second: FSIS is constantly updating its food safety protocols and posts this information online.

Animal Care & Handling

Live Animal Care

- Has a significant impact on cutability and meat quality
- Is important from farm to processor
- Includes factors such as:
  - growth hormone implants
  - antibiotics
  - water and feed
  - illness
  - handling practices
  - weather

Growth-Promoting Implants

- Are used in cattle and sheep to increase rate of growth and weight gain
  - increase feed efficiency
  - aid in muscle growth and influence carcass traits

Growth-Promoting Implants

- Contain either natural or synthetic hormones
  - natural hormones are gender-based hormones
    - estradiol
    - progesterone
    - testosterone
  - synthetic hormones are based on natural hormones but modified in a lab
    - zeranal
    - trenbolone acetate

Growth-Promoting Implants

- Are placed in the ear of cattle or sheep
- Must be approved by the FDA for use
  - determine use
  - establish limits
  - create tolerance levels
  - establish and enforce withdrawal period
- Are NOT approved for use in swine or poultry

Beta-agonists

- Are synthetic chemicals which shift nutrients away from fat production to the promotions of lean muscle growth
- Allowed in the United States are:
  - ractopamine hydrochloride
  - zilpaterol hydrochloride

Antibiotics

- Are used to prevent and treat illness in livestock animals
- Help maintain a steady supply of meat from healthy animals
- Can be used in two manners:
  - administered in small, preventative doses through feed and water; known as sub-therapeutic use
  - administered in larger doses to treat illness

Antibiotics

- Must be approved for the intended use by the FDA before administered to livestock
- Have withdrawal periods which are set by the FDA and must be followed

Withdrawal Period

- Is the prescribed period of time the meat animal must not have received the compound or drug immediately preceding harvest
- Will allow ample time for the drug or hormone to pass through the animal's system
- Are set by the FDA and monitored through testing by FSIS

Safety Second: FSIS collects approximately 1.5 million samples per year from meat products to test for hormone and antibiotic residues.

Residue Levels

- Are the amounts of a drug, antibiotic or hormone left behind in a product after the withdrawal period has passed
- Are monitored by the USDA, FSIS, FDA and Environmental Protection Agency (EPA)
- Related to antibiotics and other drugs can be reduced below violative levels by veterinarians abiding by rules set by the FDA

Water

- Is essential to all life processes
- Must be provided to livestock throughout the life cycle until the point of harvest
- Aids in ease of hide removal and evisceration

Feed & Feedstuffs

- Provide all essential and non-essential nutrients
- Provide the source of energy for the animal to perform life processes, growth and development
- Are withheld from animals 12 hours prior to slaughter to aid in evisceration and reduce the likelihood of microbial contamination from visceral punctures

Illness in Livestock

- Should be addressed immediately
- Will prevent an animal from being harvested or cause its carcass to be condemned
- Can sometimes be treated with antibiotics depending on the cause of the illness

Safety Second: It is vital to read the label of any drug given to an animal as it may delay the time of harvest due to mandatory withdrawal periods.

Illness in Livestock

- Should result in the ill animals being separated from other healthy animals
- Due to regulations concerning Bovine Spongiform Encephalopathy (BSE), non-ambulatory or “downer” cattle cannot be harvested for human or animal consumption
- Is monitored by veterinarians who are employed by producers, processors and the federal government

Handling Procedures

- May influence red meat yield due to bruising and meat quality
- Should aim to prevent injury and stress to the animal
- Include:
  - not shipping horned cattle in confined spaces to prevent bruising
  - properly using sorting sticks to prevent bruising and lesions
  - designing working facilities to minimize stress and injury
  - avoiding short-term stress in swine immediately prior to slaughter to prevent meat quality issues
  - preventing long-term stress in all livestock to prevent degradation of meat quality

Adverse Weather Conditions

- Can increase the incidence of illness in animals due to rapid changes
  - hot to cold
  - dry to wet
- Should be monitored during high stress situations in an animal's life
  - calving, farrowing and lambing
  - weaning
  - shipping

Adverse Weather Conditions

- Can effect rate of gain
  - in exceptionally hot weather, animals will consume less feed, reducing gain
  - in exceptionally cold weather, animals will consume more feed, utilizing the energy to maintain body temperature, not add weight
- Are out of the producer's and processor's control, but its effects can be mediated through proper handling and monitoring procedures


Meat
Nutrition

Meat in the Diet

- Is important as it is a source of complete protein
  - contains all nine essential amino acids
- Provides significant amounts of essential and non-essential micronutrients
- Is measured in cooked ounces
  - the daily recommendation of protein in the diet differs by age and sex and is measured in protein ounce equivalents

The Components of Meat

- Are essential to good health
- Include:
  - protein
  - fat
  - fat-soluble vitamins
  - B-vitamins
  - iron
  - essential minerals
  - water

Protein

- Is responsible for body structure and chemical reactions essential to life
  - aid in the repair and maintenance of body cells
- Strengthens the body's immune system against infections and disease
- Maintains blood neutrality
  - pH 7.35 to 7.45
- Is most readily absorbed from natural sources such as meat

Protein

- Found in meat contain the essential amino acids:
  - Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan, Valine, Arginine

Meat Moment: Our bodies cannot synthesize essential amino acids so they must be consumed from dietary sources. Arginine is an essential amino acid for children, but not adults.

Protein

- Aids in the regulation of the water balance in the body
  - the human body is 60 percent water (H_2O)
- Can be obtained from all meat and poultry products
  - a cooked ounce of meat or poultry contains an average of seven grams of protein

Meat Moment: How many grams of protein are in a six-ounce lamb rib chop?

(6 ounces x 7 grams/ounce)= 42 grams of protein

Fat

- Is essential for the absorption of fat-soluble vitamins A, D, E and K
- Contain the most energy per gram
  - 9kcal/gram
- Are made up of triglycerides, found in three natural forms:
  - monounsaturated
  - polyunsaturated
  - saturated

Meat Moment: Saturated fats contain only single bonds between carbon atoms; unsaturated fats contain one or more double bonds between carbon atoms.

Fat

- In a serving of lean meat, is less than the fat in an eight-ounce glass of whole milk
  - serving size of lean meat is three and a half ounces
- Found in beef, pork and veal, is less than 50 percent saturated
  - saturated fats are typically viewed as “bad” fats
- Also contains cholesterol

Meat Moment: Less than 30 percent of a person’s daily caloric intake should be from fats.

Cholesterol

- Is a sterol
  - waxy alcohol found in animal tissues and products
- Is used to:
  - synthesize vitamin D
  - create hormones
  - form bile salts to aid in digestion of fats
- Coats nervous system tissues, facilitating nerve impulse transmission

Cholesterol

- Can be obtained from dietary sources or produced by the body
  - liver may produce two to three times more cholesterol than a person consumes

B Vitamins

- Are water soluble vitamins
- Aid the body in obtaining energy from food
- Help to build red blood cells
- Found in meat and organ meats, include:
  - thiamine (B1)
  - riboflavin (B2)
  - niacin (B3)
  - B6
  - biotin (B7)
  - B12
  - folic acid

Essential Minerals

- Must be obtained from dietary sources
- Aid in the regulation of body processes
- Found in meat include:
  - Copper, Iron, Magnesium, Manganese, Phosphorus, Potassium, Selenium, Zinc

Meat Moment: Vegetarians are challenged in maintaining sufficient levels of amino acids, vitamins, calcium, iron and zinc. Many vegetarians must include nutritional supplements in their diet.

Iron from Meat

- Is the best food source of heme iron
  - heme iron is the most readily absorbed form of iron
- Is essential for:
  - formation of red blood cells
  - enhancing the absorption of non-heme iron

Meat Moment: The human body absorbs one to 14 times more heme iron than non-heme iron. A person with low blood iron levels is considered iron deficient anemic.

Ounce for Ounce

- Lean meat contains less calories than some fruits and vegetables
- Lean meat contains less fat than:
  - peanut butter
  - cheddar, Swiss and American cheeses

Three Ounces of Lean Meat

- Contains less than 200 calories
- Can contain many of one's daily nutrients:
  - beef: more than half of the protein required for females over 14
  - pork: 39 percent of the Recommended Daily Allowance (RDA) for zinc
  - lamb: 74 percent of the RDA for Vitamin B12

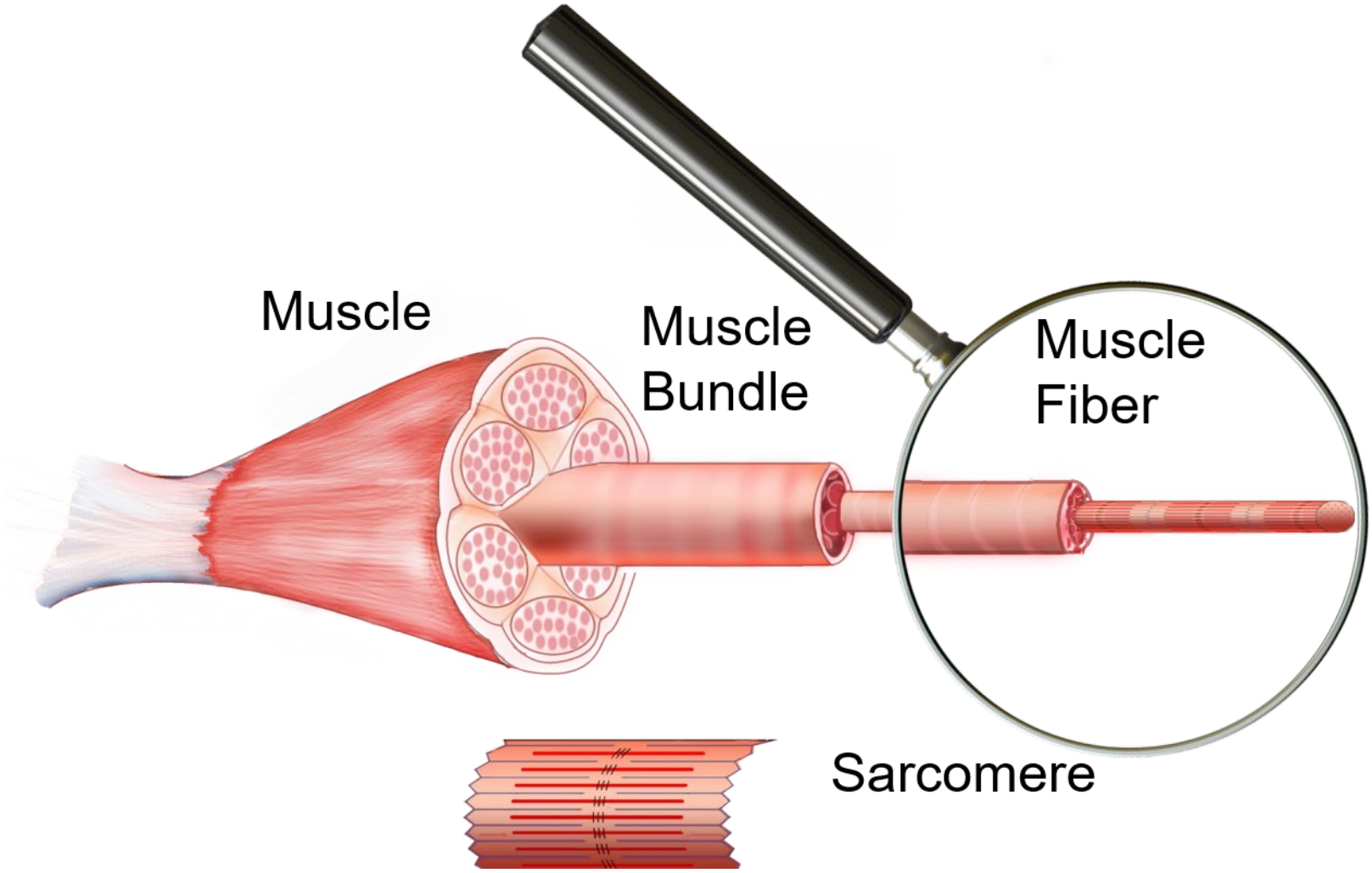
Purchasing Meat

Muscles

- Are comprised of thousands of basic muscle contractile units known as sarcomeres
- Consist of two primary contractile proteins, myosin and actin
  - myosin is the thick myofilament in the sarcomere
  - actin is the thin myofilament in the sarcomere
- Are converted to meat postmortem
  - meat varies in tenderness based on the muscle it is from

Meat Moment: As a general guide, tenderness decreases the farther away from the center of the carcass the cut of meat is from.

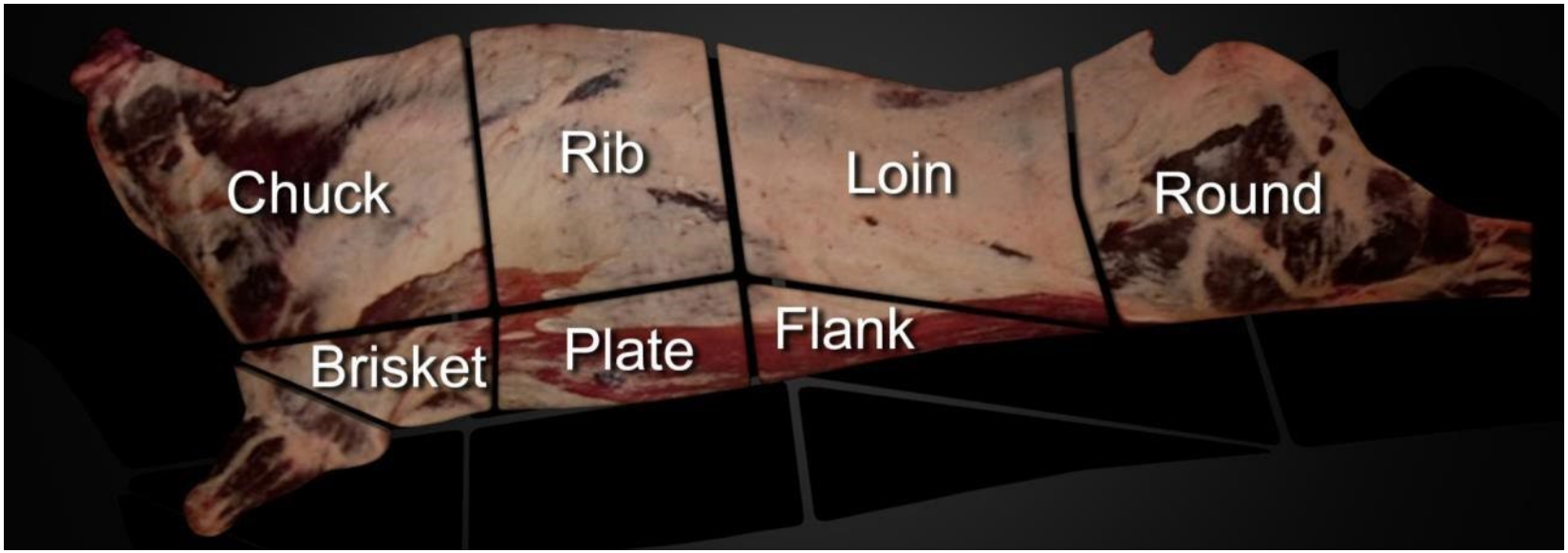
Sarcomere



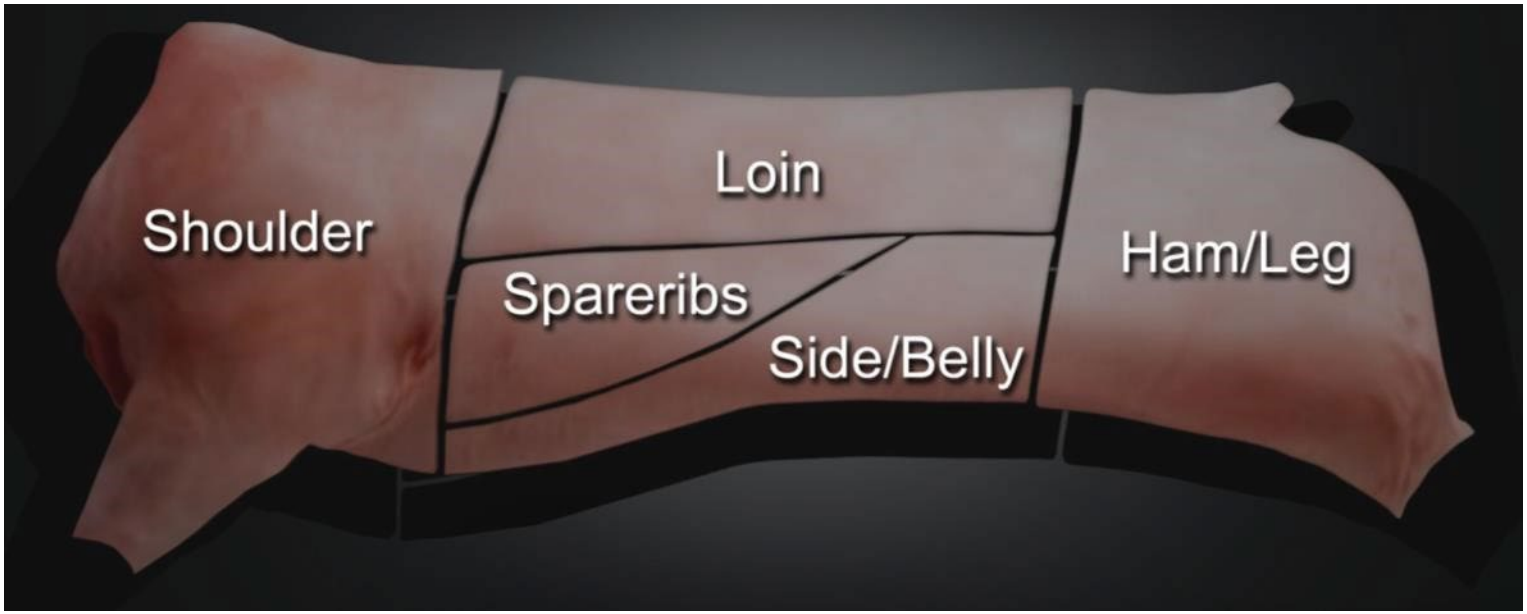
Primal Cuts

- Are the large pieces into which a carcass is divided
- Break down into sub-primal cuts, then retail cuts
- Are known by different names for each species

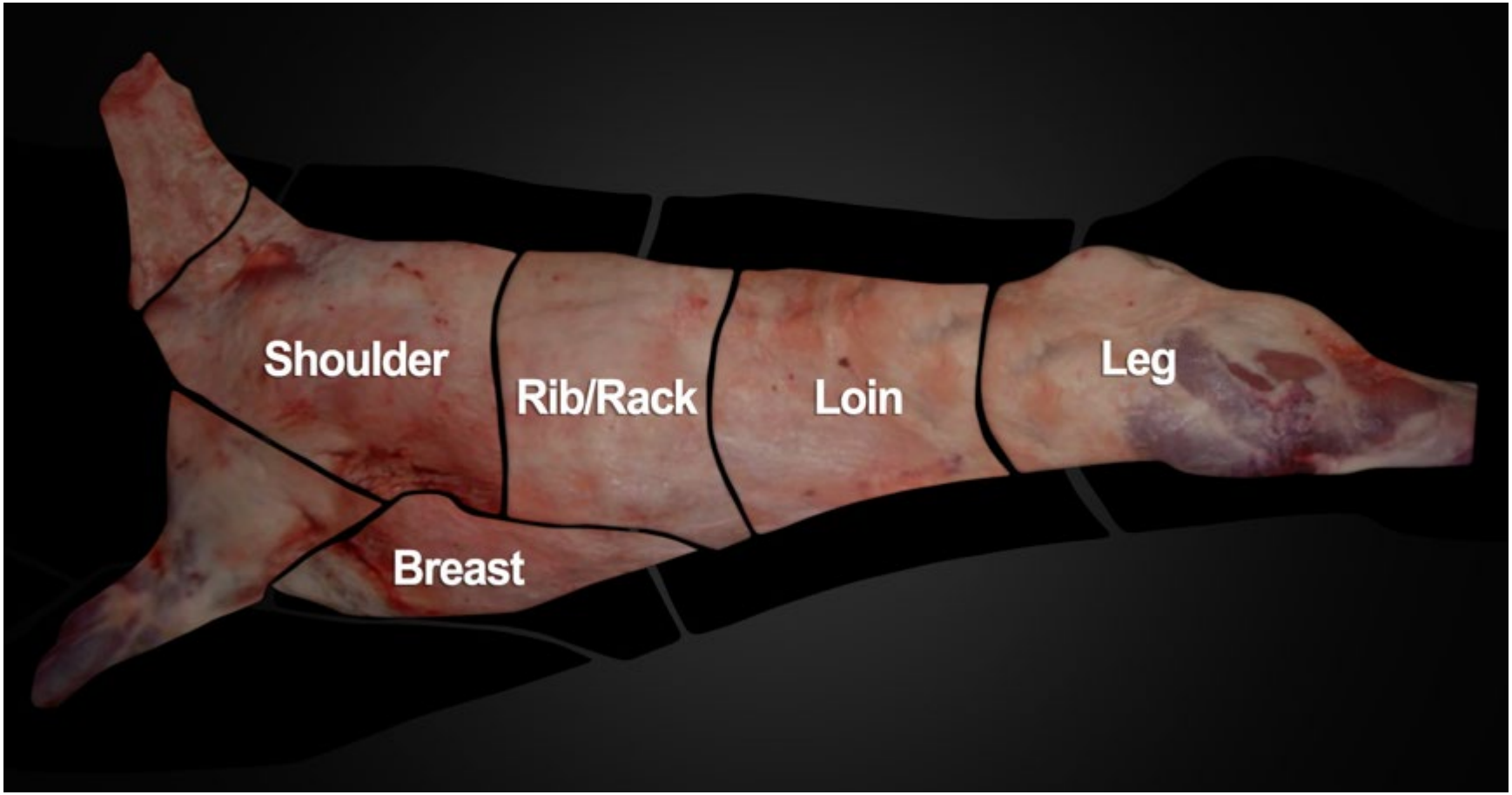
Primal Cuts: Beef



Primal Cuts: Pork



Primal Cuts: Lamb



Sub-Primal Cuts

- Are smaller portions of primal cuts
  - example: chuck roll from the chuck in beef
- Can be cut into roast, steaks and other smaller portions to be purchased at retail establishments

Retail Cuts

- Are the portions of meat sold in retail establishments, such as grocery stores
- Are labeled on a uniform basis according to the Uniform Retail Meat Identity Standards
  - a pork sirloin chop in California is the same cut as a pork sirloin chop in Maine

Ground Beef vs. Hamburger

Ground Beef	Hamburger
Shall NOT contain more than 30 percent fat	May contain added beef fat, up to 30 percent of the total

Meat Moment: According to USDA regulations, if ground beef or hamburger contains more than 30 percent fat, it is considered “adulterated” and the establishment selling the product is subject to fines.

Regulatory Standards for Hams

Regulations	
Ham	20.5% or more PFF
Ham with Natural Juices	18.5% PFF
Ham Water Added	17.0% PFF
Ham & Water Product	<17.0% PFF
Country-Cured Ham	Dry-cured; Must shrink at least 18%; At least 4% salt

Meat Moment: PFF stands for Protein Fat-Free. PFF refers to the meat protein content expressed as a percentage of non-fat portion of the finished product. PFF reflects the presence of added ingredients, including water, and relates labeling claims to the percent of meat protein in the product on a fat-free basis.

Retail Packaging

- Has three common methods:
  - overwrap
  - modified atmosphere packaging
  - vacuum packaging

Meat Moment: The meat and poultry industries produce more than 92 billion pounds of product in the United States alone, equaling almost 300 pounds per U.S. citizen.

Overwrap

- Is usually done in the retail establishment
- Is a plastic wrapping over the product and tray

Modified Atmosphere Packaging

- Is the packaging of meat in a tray with a mix of gases different from the normal composition of our atmosphere
- Uses mixes of carbon dioxide, oxygen and other inert gases
  - common mix is 80 percent oxygen and 20 percent carbon dioxide

Vacuum Packaging

- Eliminates almost all air from the package
- Causes fresh meat to appear dark until exposed to air
- Results in a distinct odor after opening which quickly dissipates
- Has two main advantages:
  - increases length of time meat can be kept
  - decreases shrinkage of meat due to moisture loss

Labeling

- Is required on all meat products by the FSIS
- Requirements include:
  - product name
  - inspection mark
  - establishment number
  - name and address of producer or distributor
  - net weight statement
  - ingredient list
  - handling instructions

Net Weight

- Is the total weight of the food product, minus the weight of the packaging materials
  - example:
    - A package of two lambchops weighs 11 ounces. The packaging weighs 3 ounces. What is the net weight of the product?
      - answer: 11 oz. – 3 oz. = 8 oz. net weight

Net Weight

- May change from packaging to counter due to moisture loss during processing and shipping

Meat Moment: To calculate the cost per serving of meat, divide the cost per pound of the meat bought by the number of servings you expect per pound.

Product Date

- Can be worded in several ways
  - "Best if Used By"— should be used by this date for best taste and texture
  - "Use By"— denotes date by which product should be used and still be considered safe
  - "Sell by Date"— food product should be sold by this date; consumer has a reasonable time after purchase for use

Meat Moment: "Use By" labels may also include "Or Freeze By." Consumers MUST pay attention to this date, especially with MAP packaged products due to the delay in spoiled appearances.

Types of Differentiated Products

- Can be a type of marketing, treatment or program monitored by the USDA
- Examples:
  - branded programs
  - aged
  - organic

Branded Programs

- Have standards for qualification
- Place a premium price on their product
- Are viewed as a luxury item with guaranteed quality
- Examples:
  - Certified Angus Beef®
  - Nolan Ryan's Guaranteed Tender Beef
  - *Chairman's Reserve*® Premium Pork

Aging of Meat

- Develops additional tenderness and flavor
- Requires strict control of factors such as:
  - temperature
    - to control microbial growth and rate of tenderization
  - humidity
    - to control dehydration

Meat Moment: Beef is the most commonly aged meat. Pork and lamb are harvested at a much younger age, resulting in meat which is naturally more tender.

Aging Methods

- Include:
  - dry aging
    - meat is held for ten days to six weeks at 34º to 38ºF (1º to 3ºC) in a humidity-controlled cooler
  - wet aging
    - meat is vacuum packaged in moisture-proof vapor film, then refrigerated for various time periods based on cut and presence of bones

Certified Organic

- Is monitored by the USDA's National Organic Program (NOP)
- Has specific rules to obtain organic status

Organic Meat

- Originates from animals which have only consumed certified organic feed and feedstuffs, forages and pasture
- Is from animals which have not received antibiotics
  - antibiotics can be used to treat disease; however, the animal will lose its organic status

Organic Meat

- Can be from animals which have received vaccines but no growth-promoting agents
  - NOP rules dictate which vaccines allow an animal to keep its organic status
- Is processed in a facility approved for organic meat processing
- Receives a higher than market price at retail

Safety Second: ALL food safety procedures and practices supersede organic regulations.

Natural

- Is a labeling term monitored by the FSIS
  - *"A product containing no artificial ingredient or added color and is only minimally processed. Minimal processing means that the product was processed in a manner that does not fundamentally alter the product. The label must include a statement explaining the meaning of the term natural (such as "no artificial ingredients; minimally processed")."*- Meat and Poultry Labeling Terms, FSIS, 2011

Maturity Classes

- Divide meat into categories based on age
- Applies mainly for red meat animals (i.e., cattle and sheep)
- Are not used for pork; most hogs in the United States are harvested at approximately the same age

Beef Maturity Classifications

Bob Veal	Veal	Baby Beef	Short-Fed	Long-Fed
From calves under 150 lb.	From calves under one year of age	From cattle with a live weight of <700 lb.; also known as calf	Cattle fed in a feedlot from 90 to 130 days, 750-850 lb., live weight	Cattle fed in a feedlot for more than 130 days
	Desired for tenderness, flavor and pale color	Strictly fed milk and grass; have yellow fat color due to carotene in grass	Good cutability with little to no excess fat	Lower cutability and higher chances of carrying excessive fat

Lamb Age Classes

Lamb	Mutton
Meat from a young sheep less than one year of age	Meat from a sheep more than one year of age
Tender and mild in flavor	More intense flavor; preferred in some cultures over lamb

Yield Grades

- Are the numerical measurement of the percentage boneless, closely trimmed retail cuts (%BCTRC) of a carcass
  - cutability
- For beef and lamb are represented by numbers 1 to 5

Yield Grade	%BCTRC
1	> 52.3
2	52.3-50.0
3	50.0-47.7
4	47.7-45.4
5	< 45.4

Quality Grading

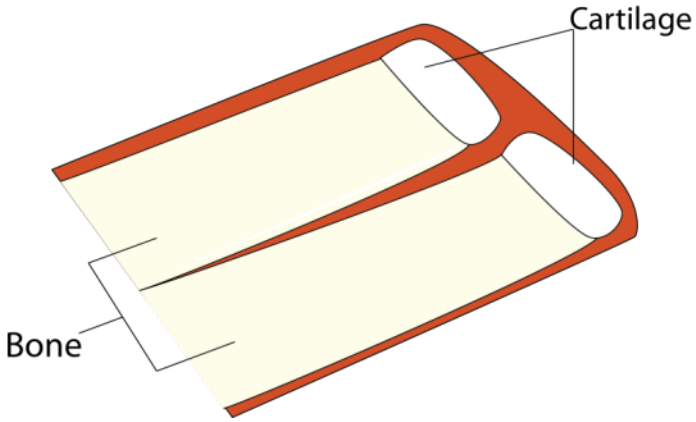
- Is most commonly discussed in relation to beef
- Is a voluntary practice, paid for by the producer and processor
- Is performed by the USDA Agricultural Marketing Service
- Serves as a predictor of palatability
  - tenderness, juiciness and flavor of the cooked product

Quality Grades

- In beef, factors evaluated include:
  - physiological age of the carcass known as carcass maturity score (A, B, C, D, E)
    - physiological age is an estimate of the actual chronological age
  - marbling
    - small flecks of fat within the ribeye muscle
  - color, firmness and texture of lean color

Carcass Maturity Score

- Is determined by examining the amount of ossification in the cartilaginous buttons on the sacral and lumbar vertebrae
- Divides carcasses into five maturity groups



Carcass Maturity	Percent Ossification	Approximate Live Age (Months)
A	0-5	9-30
B	5-35	30-42
C	35-70	42-72
D	70-90	72-96
E	> 90	> 96

Lean Evaluation

- Includes:
  - degree of marbling
  - color
    - bright cherry red is ideal
  - firmness
  - texture

Degrees of Marbling

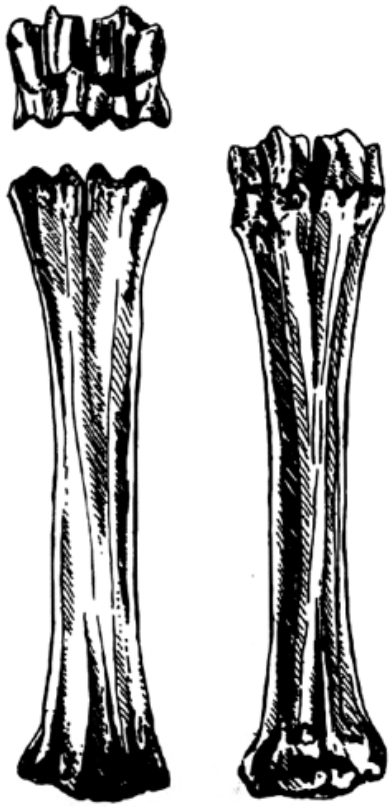
Grade for "A" Maturity Beef	Marbling Score
Prime +	Abundant$^{0\text{-}100}$
Prime º	Moderately Abundant$^{0\text{-}100}$
Prime –	Slightly Abundant$^{0\text{-}100}$
Choice +	Moderate$^{0\text{-}100}$
Choiceº	Modest$^{0\text{-}100}$
Choice–	Small$^{0\text{-}100}$
Select +	Slight$^{50\text{-}100}$
Select–	Slight$^{0\text{-}49}$
Standard +	Traces$^{00\text{-}100}$
Standard–	Practically Devoid$^{0\text{-}100}$

Quality Grades

- In lamb, factors evaluated include:
  - physiological age of the carcass
  - flank fat streaking
  - lean and external fat color and firmness
  - conformation

Physiological Age of Lamb

- Is determined by evaluating the joints of the front shank joints and ribs
  - left is a break joint, right is a spool joint
  - ribs will be varying degrees of round and red or flat and white



Joints	Age(Months)	Classification
2 break	2-14	Lamb
1 break, 1 spool	12-25	Young Mutton
2 spool	> 25	Mutton

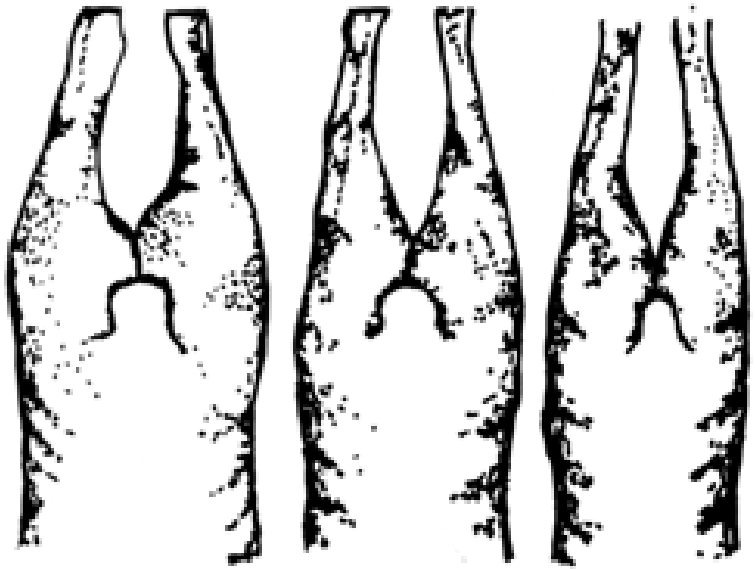
Fat Evaluation of Lamb

- Is examined at the flank, along with internal and external fat covering
  - internal and external fat is examined for color and firmness, not just amount

Meat Moment: Which lamb is fatter, the one on the right or left? How can you tell?

Conformation in Lamb

- Is an estimation of carcass composition, primarily carcass muscling and thickness relative to carcass length
  - the thicker and/or heavier muscled a carcass, the higher the conformation score



USDA Quality Grades

- For beef includes:
  - Prime
  - Choice
  - Select
  - Standard
  - Commercial
  - Utility
  - Cutter
  - Canner
- For lamb includes:
  - Prime
  - Choice
  - Good
  - Utility
  - Cull

Quality Grades

- Are stamped on the carcasses by a USDA Grader
- Are an important marketing tool
  - more than 90 percent of the lambs slaughtered in the U.S. grade USDA Choice or higher
  - most of the beef in U.S. grocery stores is USDA Select with some USDA Choice, Prime and branded programs

Meat Storage & Handling

SUBCHAPTERS

- Meat Storage
- Meat Handling

Refrigerator Storage Times

- Are affected by temperature
  - lower temperatures increase storage time
- Are designed to provide the consumer with a safe product which has retained its quality
- Limit bacterial growth on meat's surface and within ground products

Safety Second: Bacteria will still grow at refrigeration temperatures (40º to 33ºF; 4º to 0ºC), but much slower than at room temperature (72ºF, 22ºC).

Refrigerator Storage Times

Beef, Lamb, Pork & Veal	
Type or Description	Refrigerate (40º F)
Ground, hamburger, stew meat, variety meats (tongue, liver, heart, kidney, chitterlings)	1-2 days
Chops, roasts, steaks	3-5 days
Chops, pre-stuffed	1 day
Corned Beef (in pouch, with pickling juices)	5-7 days
Bacon	7 days
Ham (Fully Cooked) Slices Half Whole	 3-4 days 3-5 days 7 days

Refrigerator Storage Times

Sausages & Lunch Meats	
Type or Description	Refrigerate (40º F)
Hard Sausage (Jerky sticks, Pepperoni)	2-3 weeks
Raw Sausage (Beef, Chicken, Pork, Turkey)	1-2 days
Smoked Sausage (Breakfast Links, Patties)	7 days
Lunch Meat (Deli-Sliced/Store-Prepared)	3-5 days
Hotdogs Opened Unopened	 1 week 2 weeks
Summer Sausage Labeled “Keep Refrigerated” Opened Unopened	 3 weeks 3 months

Freezer Storage

- Should be at or below 0ºF (-18ºC)
- Long term
  - should be in a deep-freeze type freezer or in a unit which separates the freezer from the refrigerator
- Short term
  - single door freezer/refrigerators should only be used for short-term storage of previously frozen meats

Meat Moment: If repackaging meat before freezer storage, choose a moisture-proof wrap, such as freezer storage bags, heavyweight plastic wrap, aluminum foil or freezer paper coated with plastic.

Freezer Storage

- Keeps meat safe to eat as long as the meat has remained frozen
- Can cause the quality of meat to deteriorate
- May result in freezer burn or oxidative changes in the meat

Meat Moment: Rancidity is the result of oxidative changes in fat found in foods and can result in undesirable off-flavors, aromas and textures.

Freezer Burn

- Is the dehydration of the surface tissues of a food
- Can be caused by:
  - improperly wrapping foods
  - punctures in the packaging which allow freezer air to come in contact with the food
- Compromises palatability
  - toughens food
  - results in rancid or tasteless cooked food

Freezer Storage Times

Beef, Lamb, Pork & Veal	
Type or Description	Freezer (0º F)
Ground, hamburger, stew meat, variety meats (tongue, liver, heart, kidney, chitterlings)	3-4 months
Chops, roasts, steaks	4-12 months
Chops, pre-stuffed	do not freeze well
Corned Beef (in pouch, with pickling juices)	Drained, 1 month
Bacon	1 month
Ham (Fully Cooked) Slices Half Whole	 1-2 months 1-2 months 1-2 months

Freezer Storage Times

Sausages & Lunch Meats	
Type or Description	Refrigerate (40º F)
Hard Sausage (Jerky sticks, Pepperoni)	1-2 months
Raw Sausage (Beef, Chicken, Pork, Turkey)	1-2 months
Smoked Sausage (Breakfast Links, Patties)	1-2 months
Lunch Meat (Deli-Sliced/Store-Prepared)	3-5 days
Hotdogs Opened Unopened	 1-2 months 1-2 months
Summer Sausage Labeled “Keep Refrigerated” Opened Unopened	 1-2 months 1-2 months

Variables of Home Freezer Storage

- Include:
  - condition of the meat when frozen
    - how long was the meat refrigerated before freezing
  - wrapping material and method
    - was an air- and moisture-proof wrapping material used
  - rate of freezing
    - thin cuts or packages of meat will freeze faster than thick cuts or packages
  - temperature of freezer
    - meat will retain its quality best and freeze quickest if stored in a very cold freezer (<-10ºF, -23ºC)

After a Power Outage

- Meat in the refrigerator is safe for six to eight hours, unless meat temperature rises above 40ºF (4ºC) for more than two hours

Safety Second: When power fails, do NOT continuously open refrigerator door to check the temperature.

http://www.fsis.usda.gov, 2011

Re-Freezing Meat

- Can cause some deterioration of quality
  - meat could lose juiciness

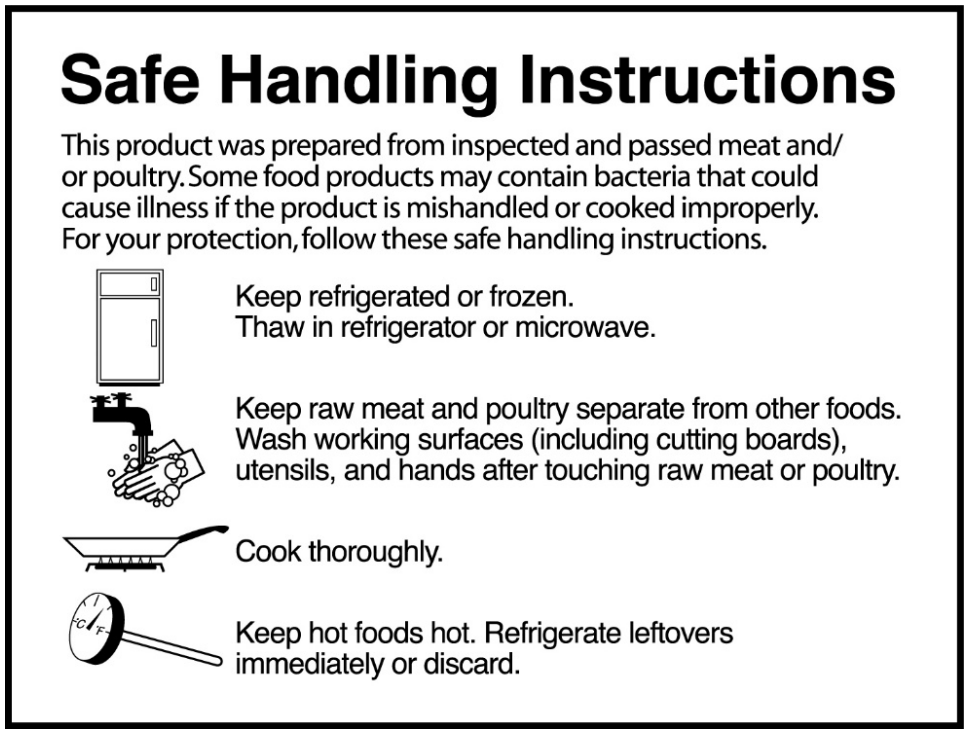
Safety Second: Raw meat which has been at room temperature for more than two hours should not be consumed or re-frozen.

Safe Handling Instructions

- Are required by the USDA on all labels of raw meat and poultry products
- Can be found on all meat and poultry products packaged at federally inspected plants and retail establishments (e.g., grocery stores)

Safe Handling Instructions

- Are the same on all types of raw meat and poultry
- Are regulated by FSIS



Safe Handling Instructions

This product was prepared from inspected and passed meat and/or poultry. Some food products may contain bacteria that could cause illness if the product is mishandled or cooked improperly. For your protection, follow these safe handling instructions.

Keep refrigerated or frozen.
Thaw in refrigerator or microwave.

Keep raw meat and poultry separate from other foods.
Wash working surfaces (including cutting boards), utensils, and hands after touching raw meat or poultry.

Cook thoroughly.

Keep hot foods hot. Refrigerate leftovers immediately or discard.

Food Safety Tips at Home

- Based on the Safe Handling Instructions include the following:
  - BEFORE handling raw meat, poultry or seafood, cooked foods or foods which will be eaten without cooking, WASH HANDS
  - use CLEAN utensils and work surfaces
  - AFTER handling raw meat, poultry or seafood, wash hands and work surfaces with hot, soapy water

Cross-Contamination

- Is the spread of harmful, pathogenic bacteria from one surface to another, one surface to a person, or person-to-person
- Can be caused by raw products such as meat, poultry, seafood or vegetables

Safety Second: Pathogenic bacteria cause illnesses. Commonly known foodborne pathogenic bacteria includes: *Escherichia coli* 0157:H7, *Campylobacter jejuni* and S*almonella spp.*

Defrosting Meat

- Should be completed in one of three ways:
  - in a refrigerator
  - in cold water
  - in a microwave oven
- Can be achieved quickest in a microwave oven

Defrosting Meat

- Will cause ice crystals within the meat to melt
  - liquid is released from the ice which can result in breaking emulsions and a loss of juiciness
- Can reveal a change in the original texture of the meat due to ice crystal formation during freezing

Meat Moment: Microwave defrosting will result in the greatest loss of juiciness.

Handling of Ground Beef

- Includes:
  - choosing a clean, completely sealed, cold package at the store
  - placing the package in a plastic bag so the juices do not drip onto other food
  - refrigerating or freezing as soon as possible after leaving the store
  - storing on the bottom shelf of the refrigerator in a plastic bag
  - keeping refrigerated and using within two days

Cooking Frozen Meat

- Can be satisfactorily achieved without defrosting
- Will increase cooking time
- Requires several modifications:
  - place meat farther from heat source
  - broil steaks and chops one and one-half to two-times longer
  - roasting time will increase one and one-third to one and one-half times

Handling Leftovers

- Should be done as quickly as possible after cooking to cool food rapidly
- Should have the ultimate goal of fast cooling to slow bacterial growth

Handling Leftovers

- Includes:
  - dividing food into small, shallow containers
  - maintaining free air circulation around containers in refrigerators
  - avoiding placing large containers of food in refrigerators
    - large containers will cool slowly and unevenly as compared to a smaller container

Safety Second: Use cooked leftovers within four days.

Freezing Cooked Meat

- Should be done quickly
- Has steps which should be followed to maintain acceptable quality
  - after cooking, remove all bones
  - leave pieces of meat large
  - wrap tightly in moisture-proof material
  - seal and freeze quickly
  - temperature of freezer should be 0ºF (-4ºC) or lower

Meat Cookery

Before Cooking Meat

- Remember, timetables are based on meat at refrigerator temperature
  - partially frozen meat will require a longer cooking time
- Make sure meat has not reached room temperature
  - increases chances of harmful bacterial growth

Cooking Temperatures

- Should not be too high
- Can increase shrinkage and cooking loss and decrease tenderness and juiciness if too high
- When too high, can result in overcooking
  - increased cost per serving due to shrinkage and loss

Internal Temperature

- Is the temperature of meat in the center of the thickest portion of the cut
- Should be monitored for food safety reasons
  - internal temperature of intact whole-muscle cuts is required because of parasites such as Trichinea
  - internal temperature required for food safety of ground products is higher than whole muscle products (e.g., ground beef versus ribeye steak)

Internal Temperatures of Beef & Lamb

- Include:

Product	Minimum Internal Temperature
Ground	160ºF; 71ºC
Roasts, Steaks and Chops	Rare: 125ºF; 52ºC
	Medium Rare: 130ºF; 54ºC
	Medium: 140ºF; 60ºC
	Well Done: 160ºF; 71ºC

Safety Second: Remember, the USDA recommends a safe internal temperature of whole muscle products to be at least 145ºF (63ºC).

http://fsis.usda.gov, 2011.

Internal Temperatures of Pork

- Must reach at least 145ºF (63ºC) to kill bacteria and the *Trichinella spiralis* parasite if present
  - incidence of trichinosis is extremely rare in the U.S.
- Include:

Product	Minimum Internal Temperature
Ground	160ºF; 71ºC
Roasts, Steaks and Chops	145ºF; 63ºC
Hams	145ºF; 63ºC before serving

Meat Moment: Let meat sit for at least three minutes after removing from heat to allow temperature to "rest" and prevent juice loss.

http://fsis.usda.gov, 2011.

Browning of Meat

- Contributes to the final taste of cooked meat
- Is affected by:
  - amount of fat in meat
  - dryness of meat and meat surface
  - distance of meat from heat source
  - cooking temperature
  - cooking time

Cooking Methods

- Differ based on the cut of meat
- Include:
  - dry
    - used for more tender, higher quality cuts and ground products
  - moist
    - used for less tender cuts or those with large amounts of connective tissue

Dry Cooking Methods

- Include:
  - broiling
  - convection oven cooking
  - deep fat frying
  - grilling
  - pan broiling
  - pan frying
  - roasting
  - smoking
  - stir frying

Broiling

- Is recommended for tender steaks and chops at least three quarters to one inch in thickness
- Uses heat from gas flames or electric coils in an oven

Broiling

- Heats only the top surface of the meat
  - should be turned once for even cooking
- Can result in excessive splattering and smoking, reduce by:
  - trimming excess fat
  - placing meat on rack in broiling pan
  - moving meat farther away from heat source

Convection Oven Cooking

- Is recommended for tender cuts of beef, pork and lamb
- Uses heated air circulated around the meat by a fan
- Enables heated air to come in contact with all meat surfaces
  - meat cooks evenly in less time compared to oven roasting

Deep Fat Frying

- Immerses meat completely in hot fat
- Is best completed when fat is between 350ºF and 360ºF (176ºC and 182ºC)
- Requires the use of a thermometer to monitor fat temperature

Grilling

- Is recommended for steaks, chops and ground meat patties
- Can be accomplished using hot coals, gas or infrared flames
- Is similar to broiling
  - heat source is from one direction

Safety Second: Never use the same platter to carry raw and cooked meat without cleaning.

Pan Broiling

- Is recommended for ground meat patties, steaks and chops less than one inch thick
- Uses a heat source below the pan
- Is accomplished by placing meat in a heavy, preheated non-stick skillet and cooking uncovered, turning only once

Pan Frying

- Is recommended for thinner sliced meats
- Browns both sides of the meat
- Uses a small amount of fat in a skillet at moderate temperature
  - turn meat occasionally

Roasting

- Is recommended for large cuts of meat
- Should be conducted in shallow roasting pan, without covering the meat
- Is usually completed in the oven or oven-type appliance

Roasting

- Uses lower temperatures to cook meat
- Enables the meat to be held in the oven for up to four hours before eating
  - less than two hours once cooked through will yield optimum eating quality

Meat Moment: Use a meat thermometer to check the internal temperature and remove from oven 5ºF to 10ºF (-15ºC and -12ºC) below desired temperature to allow meat time to sit.

Smoking Meats

- Uses a smoker or covered grill and fragrant woods and spices
- Is accomplished at lower temperatures
  - 225ºF to 350ºF (107ºC to 176ºC)
- Uses two thermometers
  - one to measure air temperature of smoker
  - one to measure internal temperature of meat

Stir Frying

- Is recommended for thinly sliced meats
- Uses only a small amount of fat in a very hot skillet
- Combines meat with large amount of vegetables stirred constantly

Microwave Cooking

- Can be used for fresh, whole muscle or ground cuts of beef, lamb and pork as well as processed meat products
- Is quick and easy, though may result in different cooked texture in comparison to other cooking methods

Meat Moment: Browning of microwave-cooked meats can be increased by brushing the surface of the meat with a mixture of browning sauce and water.

Microwave Cooking

- Methods:
  - bacon
    - four slices on a paper towel in a glass dish
    - microwave on high power for four to five minutes
  - pre-cooked sausages, such as frankfurters
    - pierce casings to vent steam and prevent casing from splitting
    - refer to manufacturer's directions, usually 30 to 60 seconds and to an internal temperature of 160ºF (71ºC)

Moist Cooking Methods

- Involve adding liquid to the container in which the meat is cooked, or allowing the meat to cook in its own juices
- Include:
  - braising
  - stewing

Braising

- Is recommended for less tender cuts of meat high in connective tissue content
- Is commonly referred to as “pot roasting”
- Involves adding a small amount of liquid to the cooking container and covering the container
  - meat is cooked until “fork tender”

Stewing

- Is recommended for smaller pieces of less tender cuts of meat
- Involves completely covering the meat with liquid and cooking extensively
  - usually with vegetables

Processed Meats

SUBCHAPTERS

- Processed Meats
- Additives

Processed Meats

- Is a broad term used to identify chemically altered meat through cooking, curing, drying, or a combination
- Can have added seasonings

Processed Meats

- Can require additional cooking or re-heating before consuming
- Includes:
  - fresh and dried sausages
  - cold cuts
  - hams
  - bacon
  - frankfurters
  - canned meat products

Processed Meats

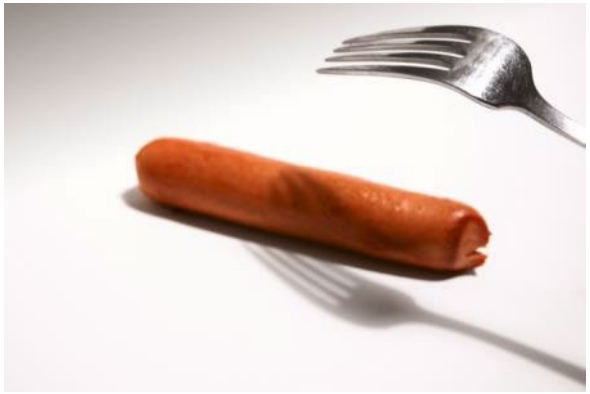
- Must have all ingredients listed on the label
  - ingredients are listed on the label in order of decreasing weight
  - the label and all ingredients must be approved by FSIS
- Are inspected by FSIS

Cold Cuts

- Are also known as luncheon meats
- Contain only skeletal meats unless stated on the label
- With variety meats, such as heart, liver or other meat sources, must be listed on the label
  - "with meat by-products"
  - "with variety meats"

Frankfurters

- Have ingredients which are monitored by FSIS
  - finished product should not contain more than 30 percent fat
  - product should contain no more than 40 percent of a combination of fat and added water



Skeletal Meat

- Is defined by the USDA as the edible muscle tissue of an animal attached to the bone
  - examples:
    - shoulder
    - brisket
    - rack
    - pork belly
- Is used to make most processed meat products such as cold cuts and sausages

Food Additives

- Are legally defined as, “any substance with the intended use of which results or may reasonably be expected to result— directly or indirectly— in it becoming a component or otherwise affecting the characteristics of any food”

Food Additives

- Perform specific functions including flavoring, coloring, preserving, extending and/or improving, or maintaining a food's natural appeal
- Include naturally occurring ingredients such as sugar, and synthetic ingredients such as color additives

Meat Moment: Salt was one of the first food additives and has been used for millenniums to change the taste of and preserve foods.

Food Additives

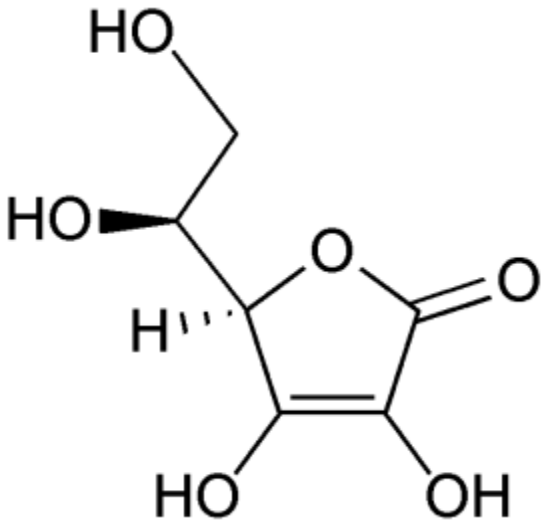
- Are used in processed meats to retard oxidation, for curing and flavoring, improving the product's taste and look, as well as to discourage unwanted bacterial growth
- Are added to processed meat products for flavor and preservation purposes
  - example: sodium chloride (NaCl) is added for flavor while sodium nitrite ($NaNO_2$) is added to prevent the growth of *Clostridium botulinum*

Antioxidants

- Are compounds which absorb oxygen, reducing or preventing the oxidation of food
- Used to prevent rancidity
- Commonly used in the U.S. are butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT)
  - both must be listed on the ingredients label and used according to FSIS regulations

Antioxidants

- Are used in processed meat
  - Ascorbic Acid (vitamin C)
    - used as a curing accelerator in combination with other curing agents to fix color at a faster rate or preserve color during storage



Curing Additives

- Are used for preserving meats
- Stabilize texture and flavor
- Fix colors in sausages and smoked meats
- Are essential to manufacturing processed meats such as:
  - bacon
  - ham
  - sausages

Curing Additives

- Include sodium nitrite and potassium nitrate
  - contribute to the characteristic flavor and texture of bacon, ham and sausage products
  - correct and preserve meat color
  - can be toxic at high levels and their use is highly regulated in cured products
  - inhibit the growth of Clostridium botulinum, which could result in fatal food poisoning if consumed

Safety Second: The American Meat Institute petitioned FSIS to allow processors to reduce nitrate levels from 120ppm to 100ppm in bacon.

Flavorings

- Contribute to, or are responsible for, the taste of a product
- Are seasonings used in a food such as natural spices, essential oils, oleoresins, extracts and synthetic flavorings
- Are divided into two types:
  - natural
  - synthetic

Natural Flavors

- Are naturally occurring whole or ground spices
- Are listed on the label as spice or flavoring
- Include powdered vegetable products such as:
  - garlic
  - celery
  - onion
  - parsley

Natural Flavors

- Such as salt or sodium chloride, and sucrose sugars are also food additives and must be listed on the label
  - sodium chloride is used in the manufacturing of almost all cured products and provides characteristic flavors and texture to processed meats
  - sucrose is used to develop or enhance flavor of a processed meat product
    - dextrose or corn syrup

Synthetic Flavoring

- Is any flavoring not an extract or naturally occurring flavor
- Must be listed on the label as artificial flavoring
- Examples include:
  - artificial sweeteners
  - some smoke flavorings

Meat Tenderizers

- Are added to a meat product before cooking
- Must be listed on the label
- Include plant enzymes:
  - papain
    - used to tenderize natural smoked sausage casings
  - bromelain
  - ficin

Potassium Sorbate

- Is used to retard mold growth on the outside of dried sausages
  - pepperoni
  - salami

Starter Cultures

- Are bacteria used for fermentation to create flavor and impart certain properties in processed meats
  - tangy flavor
  - reduce pH, thus reducing the rate of harmful bacterial growth
- Do not contain harmful bacteria
- Stop growing after a certain pH or temperature is reached during processing

Other Processed Meat Additives

- Include:
  - isolated soy proteins
    - extracted proteins from soybeans; aid in binding lean and fat for improved product texture
  - lecithin
    - found naturally in soybeans, corn and eggs; aids in maintaining an emulsion in mixes
  - mono and di-glycerides
    - derived from fats; serve to keep ingredients and seasonings evenly distributed throughout a mix

Other Processed Meats Additives

- Include:
  - phosphates
    - increase water holding capacity to reduce free juices during processing, resulting in a juicier final product; commonly sodium phosphate (Na_3PO_4)
  - water (H_2O)
    - used to dissolve curing ingredients, facilitate mixing and give products a characteristic texture and appearance; cannot exceed 10 percent of product by weight


Food
Safety

Food Safety

- Is the responsibility of producers, processors and the consumer
- Can be managed to reduce the incidence of foodborne illness and infection

HACCP

- Stands for Hazard Analysis Critical Control Points
- Is a program adopted by most commercial food processors to control hazards in food processing
- Identifies critical points where contamination occurs in a product and presents solutions
  - example:
    - Problem: shipping dock can allow for entry of rodents
    - Solution: install closed container rodent traps and seal door properly

HACCP

- Is composed of seven principles:
  - conduct a hazard analysis
  - identify critical control points (CCPs)
  - establish critical control point monitoring requirements
  - establish critical limits for each critical control point
  - establish corrective actions
  - establish record keeping procedures
  - establish procedures for verifying the HACCP system is working as intended

Ways to Minimize Foodborne Bacteria

- Include:
  - cooking
  - pasteurization
  - canning
  - freezing
  - irradiation
  - proper storage temperatures
  - high pressure treatment
  - acidification

Safety Second: The minimum internal temperature for ground meat products is 160ºF (71ºC). Whole muscle product surfaces should be cooked to 160ºF (71ºC).

Irradiation

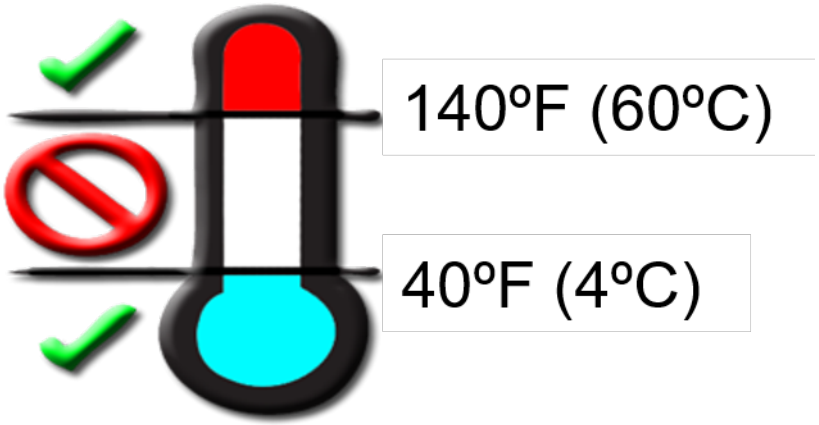
- Destroys pathogenic and spoilage bacteria in food
- Does not alter the freshness, nutritional content, physical or chemical composition, aroma, or taste of a food
- Can be performed on fresh meats, processed meats and spices

Irradiation

- Involves exposing food to a source of ionizing energy
  - gamma rays
  - machine generated electrons
  - x-rays
- Does NOT result in radioactive food
  - product never comes into contact with radioactive material and no residue results from process

Proper Storage Temperatures

- Should be followed to prevent exponential growth of bacteria
- Include:
  - below 40ºF (4ºC) for cold products
  - above 140ºF (60ºC) for hot products



The Temperature Danger Zone

- Is between 40ºF (4ºC) and 140ºF (60ºC)
- Is the range in which most foodborne pathogenic bacteria thrive
- Can be avoided by:
  - properly cooking all foods
  - heating foods to the proper temperature before serving
  - quickly cooling all food products

Safety Second: Perishable food held for more than four hours should be discarded.

Foodborne Illness

- Is most commonly caused by mishandling food
  - temperature abuse
  - cross-contamination
  - improper procedures
  - contamination after cooking

Vulnerable People

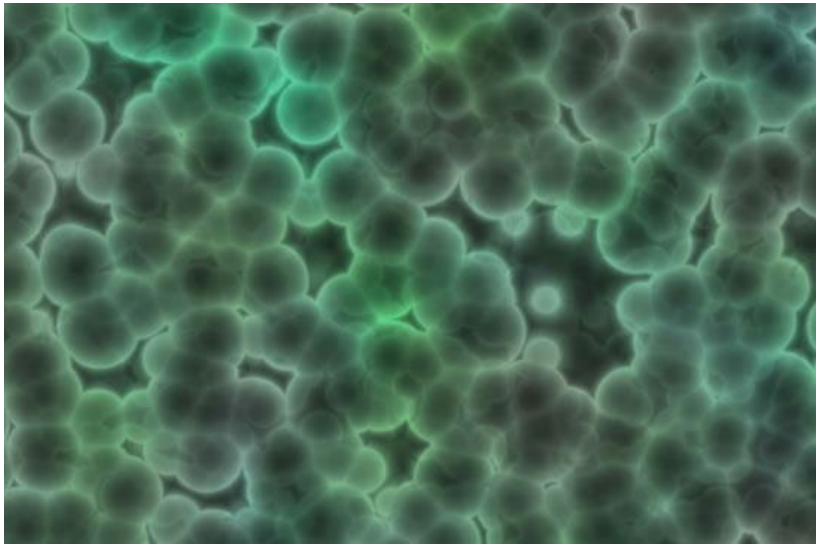
- Include:
  - senior citizens
  - pregnant women
  - young children
  - individuals with compromised immune systems
    - cancer
    - diabetes
    - liver disease
    - AIDS

Foodborne Illness

- Can be a food infection or food intoxication
  - food infection: pathogenic bacteria was in a food product consumed and made the consumer sick after eating
    - *Salmonella spp.*
  - food intoxication: pathogenic bacteria grew in the food, produced a toxin and made the consumer sick after eating
    - *Clostridium botulinum*

Bacterial Counts

- Which cause illness differ for each bacteria
  - some bacteria require higher numbers to be consumed to make an individual ill
  - the more bacteria consumed, the more likely a person is to get sick



Common Foodborne Bacteria

Illness	Botulism, food intoxication
Causative Agent	Toxins produced by *Clostridium botulinum*
Symptoms	Nausea; vomiting; fatigue; dizziness; headache; dryness of skin; constipation; impaired swallowing, speaking, respiration and coordination; double vision **<u>Ten percent of cases are fatal</u>**
Time of Onset	12 to 72 hours after consumption
Meat Usually Involved	Canned meats and seafood; smoked and processed meats and seafood
Preventative Measures	Canning at 176ºF (80ºC) for ten minutes; proper smoking and processing procedures; use of nitrites; proper cooking and refrigeration temperatures; sanitation

Common Foodborne Bacteria

Illness	*Staphylococcal* food infection
Causative Agent	Enterotoxin produced by *Staphylococcal aureus*
Symptoms	Nausea; vomiting; abdominal pain due to inflammation of the lining of the stomach and intestines
Time of Onset	12 to 48 hours after consumption
Meat Usually Involved	Foods prepared by hand which require no additional cooking, such as salads and sandwiches; milk and dairy products; meat, poultry and eggs
Preventative Measures	Wash hands properly before handling and preparing foods; do not prepare foods when ill; do not prepare foods with an exposed sore on the hands or wrists; keep the kitchen sanitary

Common Foodborne Bacteria

Illness	*Perfringens* food infection
Causative Agent	*Clostridium perfringens*
Symptoms	Nausea; occasional vomiting; abdominal pain; diarrhea
Time of Onset	8 to 24 hours after consumption
Meat Usually Involved	Cooked meat, poultry and fish held at non-refrigerated temperatures for long periods of time
Preventative Measures	Prompt refrigeration of unconsumed cooked meat, gravy and fish; maintenance of refrigeration equipment; sanitation

Common Foodborne Bacteria

Illness	Salmonellosis, food infection
Causative Agent	*Salmonella spp.*, over 1,200 species of *Salmonella* cause illness when ingested
Symptoms	Nausea; vomiting; abdominal pain; diarrhea; fever; possible chills and headache
Time of Onset	12 to 24 hours after consumption
Meat Usually Involved	Insufficiently cooked or re-heated meat, poultry and eggs; products kept unrefrigerated for long periods of time
Preventative Measures	Properly cooking food products; proper refrigeration and packaging; cleanliness of food handlers; sanitation of equipment

Common Foodborne Bacteria

Illness	Listeriosis, food infection
Causative Agent	*Listeria monocytogenes*
Symptoms	Fever; headache; nausea; vomiting; monocytosis, meningitis; septicemia; miscarriage; localized external and internal lesions; pharyngitis
Time of Onset	Unknown, approximately four days to three weeks after consumption
Meat Usually Involved	Eggs; processed meats; fresh meats and poultry products; raw and smoked fish
Preventative Measures	Proper hygiene practices; sanitation of equipment and facilities; heat products immediately before consumption, even cold-cuts and other ready-to-eat meats

Common Foodborne Bacteria

Illness	Trichinosis, food infection
Causative Agent	*Trichinella spiralis,* a nematode worm
Symptoms	Nausea; vomiting; diarrhea; profuse sweating; fever; muscle soreness
Time of Onset	2 to 28 days
Meat Usually Involved	Improperly cooked pork and products containing pork
Preventative Measures	Cooking pork to at least 137ºF (58ºC); freezing and storage of uncooked pork at 9ºF (-12ºC) or lower for a minimum of 20 days; avoid feeding swine raw garbage

Common Foodborne Bacteria

Illness	*E. coli, E. coli* O157:H7; food infection
Causative Agent	*Escherichia coli*
Symptoms	Severe abdominal cramps; bloody diarrhea; nausea; vomiting; diarrhea; possible complications from hemolytic uremic syndrome
Time of Onset	3 to 4 days
Meat Usually Involved	Raw and undercooked meat
Preventative Measures	Cooking all ground meat to an internal temperature of 160ºF (71ºC); cooking all exposed surfaces of whole muscle products to an external temperature of 160ºF (71ºC)

Resources

- “Lessons on Meat.” National Livestock and Meat Board, Beef Promotion and Research Board, and National Pork Board. 1991.
- Savell J.W., Smith G.C. (2009). Meat Science Laboratory Manual. (8 ed.). American Press.
- Romans, J. R., Costello, W. J., Carlson, W. C., Greaser, M. L., & Jones, K. W. (2000). The Meat We Eat. (14 ed.). Prentice Hall.
- “The Guide to Identifying Meat Cuts. Cattlemen’s Beef Board and National Cattlemen’s Beef Association. 2009.
- “The Seven HACCP Principles.” Food Safety and Inspection Service. (1998). Retrieved 2011 from: http://www.fsis.usa.gov/oa/background/keyhaccp.html
- United States Department of Agriculture. USDA. Retrieved 2011: http:// www.usda.gov
- “Yellow pages- answers to predictable questions consumers ask about meat and poultry.” American Meat Institute Foundation, Washington, D.C. 1994.

Reviewers

- 2012
  - Chairman Randy Harp, Ph.D., Tarleton State University, Professor of Animal Sciences
  - Co-Chariman Jodie Pitcock, USDA Market Reporter, USDA Livestock & Grain Market News
  - William Benjy Mikel, Ph.D., Associate Vice President, International Programs. Executive Director, International Institute. Director, Food Science Institute. Mississippi State University
  - Rudy S. Tarpley, Ph.D., Associate Professor & Head, Agricultural & Consumer Sciences, Tarleton State University
  - Renée Gebault-King, Ph.D. Candidate, Soil Science, Renewable Resources Department, University of Wyoming
  - David Bishop, Turks Meat Market
- 2019
  - Chairman Wendy Woerner, National FFA Meats Evaluation & Technology CDE
  - Dale Woerner, Ph.D., Texas Tech University, Associate Professor, Cargill Endowed Professor in Sustainable Meat Science
  - Stacy M. Scramlin Zuelly, Ph.D., Purdue University, Assistant Professor of Meat Science
  - Jacob Nelson, Oklahoma State University, Meat Processing Specialist

Acknowledgements

Production Coordinators
Olivia Mitchell, Kelly Adams

Graphic Designers
Daniel Johnson, Melody Rowell

Director of Brand Management
Megan O'Quinn

Production Manager
Maggie Bigham

Quality Control Director
Angela Dehls

V.P. of Brand Manager
Clayton Franklin

Executive Producer
Gordon W. Davis, Ph.D.