Butcher's Guide to Red Meat

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Introduction

The purpose of this guide is to serve as an educational resource to help bridge the knowledge gap between livestock producers, meat processors, and consumers to aid in furthering processor education and to serve as a resource to reference when answering consumer questions.

Beef, pork, and lamb fabrication will be discussed in this guide, including terminology such as directional anatomy terms and important skeletal structures to know. Carcass yields, fresh meat color, product storage, packaging options, beef product aging, grass-finished versus grain-finished carcass characteristics, and a trouble shooting section are also addressed. It is our hope that the information within this guide will be a useful tool in helping processors educate themselves and their consumers. Welcome to the Butcher's Guide to Red Meat.

Acknowledgement

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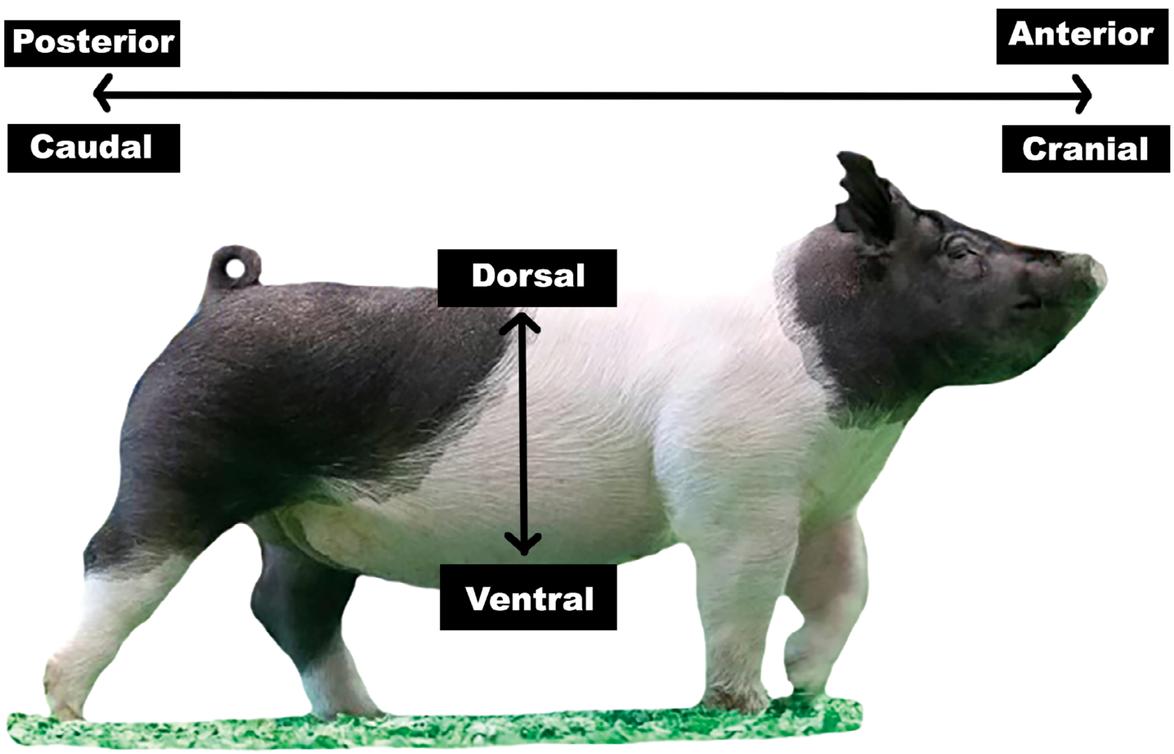
Directional Anatomy Terminology

Directional anatomy terminology describes various locations and directions on a carcass. This is not only helpful in understanding where to make cuts, but it is also useful for understanding what part of the carcass various cuts come from.

Throughout this guide, directional anatomy terminology is utilized to explain orientation of structures and where to cut when breaking down a carcass. Directional terms are universal for every species. Below is a diagram and explanations of these terms on a pig. Keep in mind, several of the terms have similar meanings: anterior and cranial both indicate toward the front, while posterior and caudal both mean toward the rear.

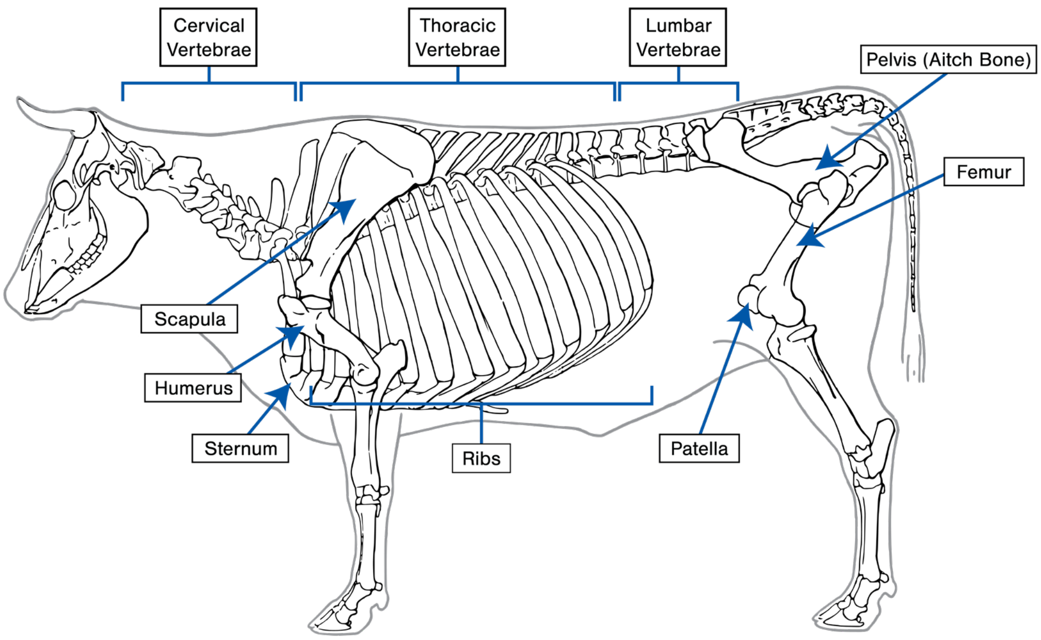
- **Anterior** means toward the head.
- **Posterior** means toward the rear.
- **Dorsal** means toward the topline.
- **Ventral** means toward the underside.
- **Cranial** means toward the head.
- **Caudal** means toward the rear.

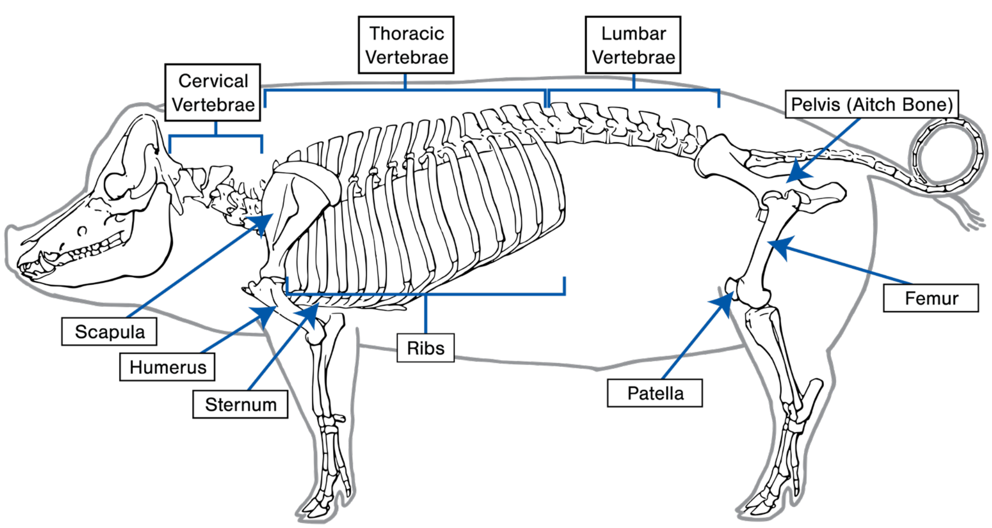


Skeletal Structures

Skeletal structures within a carcass can help identify different primals as well as serve as excellent guide points for cuts to be made during fabrication. Certain skeletal structures have special names and are unique in appearance. Bones can be oddly shaped making fabrication significantly more difficult if you are unfamiliar with the shape. Below is a list of unique skeletal structures, along with their common names, which are depicted on the skeletons below.

- **Cervical Vertebrae**
- **Scapula** (shoulder blade)
- **Thoracic Vertebrae**
- **Patella** (kneecap)
- **Lumbar Vertebrae**
- **Aitch Bone** (part of pelvic bone)

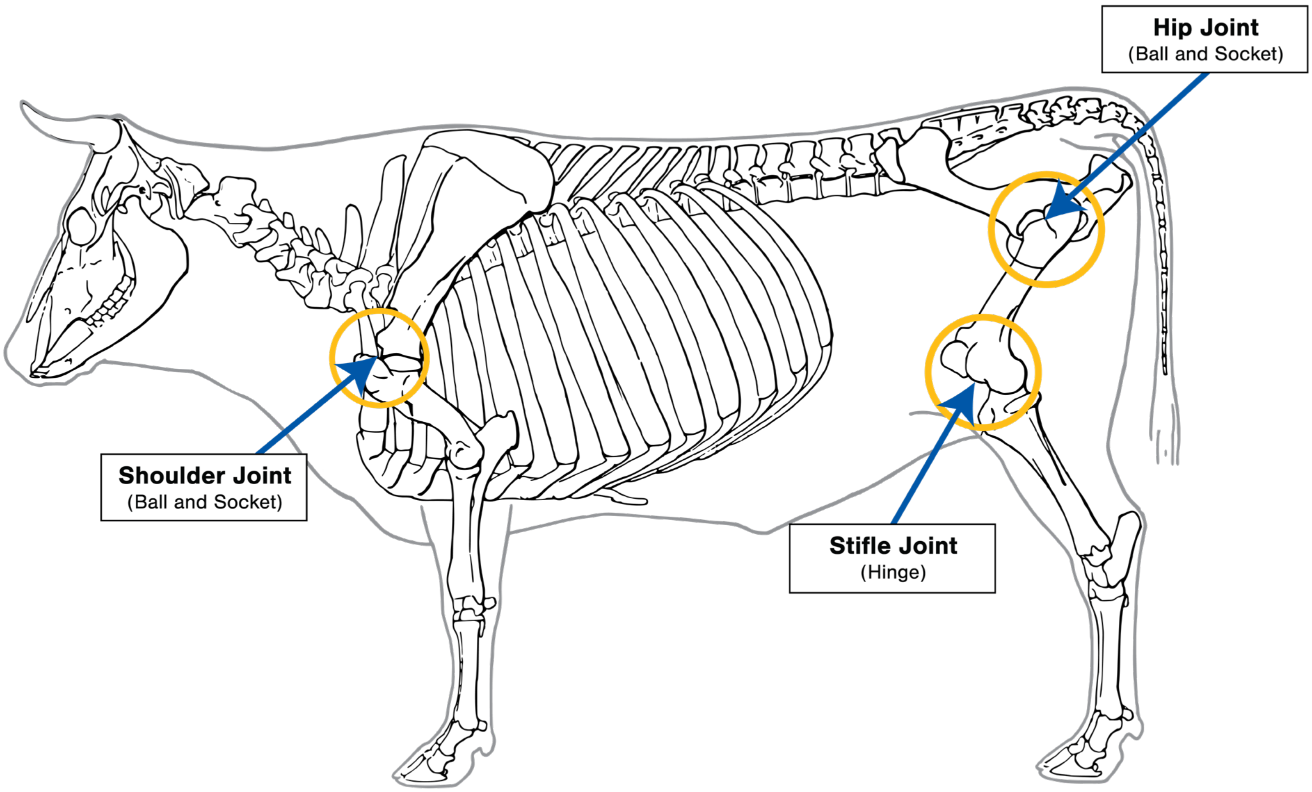




Important Joint Structures

Various joints exist within a carcass and are the place where two or more bones meet. Cutting between joints is crucial to fabrication. While there are many types of joints two will be commonly encountered during fabrication.

- **Ball and socket:** hip joint, shoulder joint
  - This type of joint has a round head-like structure of bone (ball) resting within a rounded depression of bone (socket). A ball and socket joint enables freer movement, and it is the most moveable joint in the body. Examples of a ball and socket joint include both the shoulder and hip joint.
- **Hinge:** stifle joint (knee)
  - This hinge-type joint enables movement in only one direction. Examples of a hinge joint include the elbow and the knee.

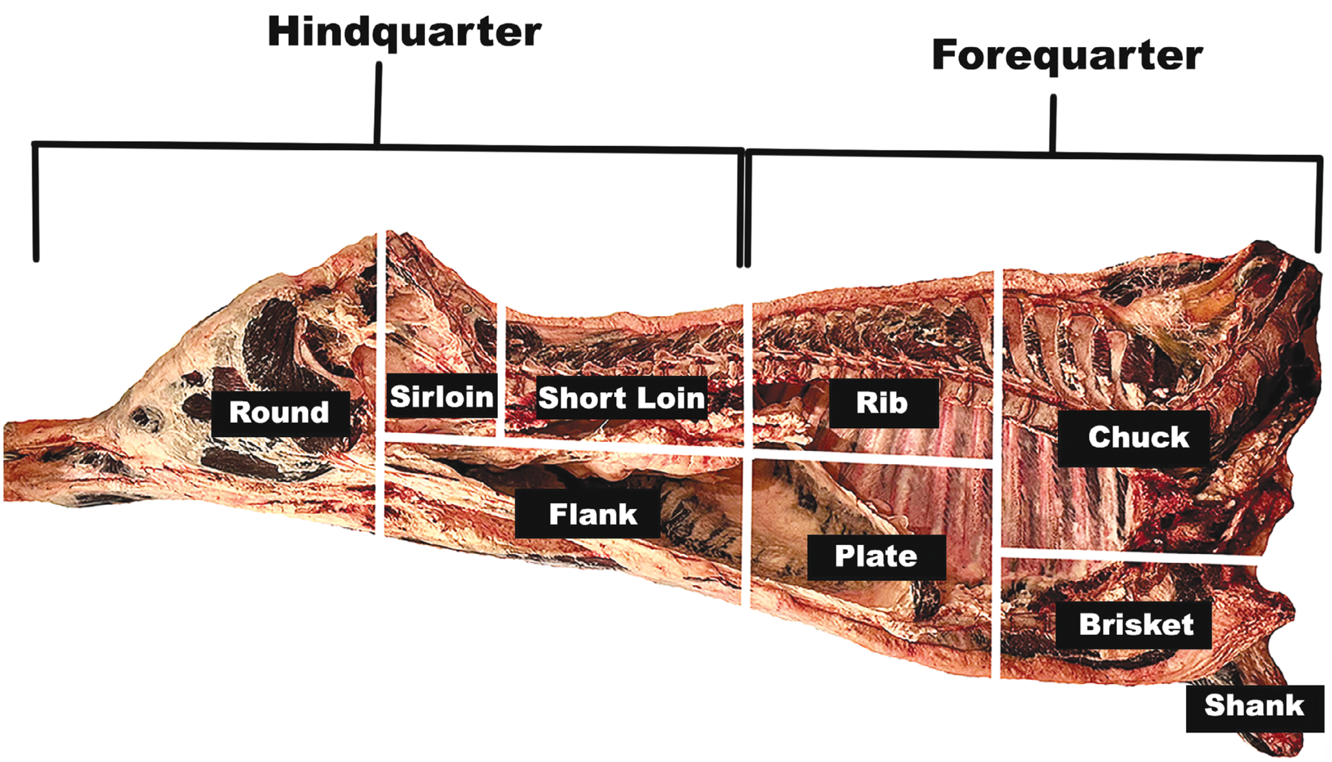


Beef Carcass Fabrication

End product goals influence how a carcass is fabricated. It is important to fabricate cuts that customers are willing to purchase. Within this section, beef primals, beef fabrication, yield differences, and different names of common beef cuts will be discussed.

Beef Primals

Beef sides are initially broken into nine different parts called primals. These primals are grouped into the forequarter or hindquarter of the carcass. Primals from the forequarter of the carcass include the chuck, rib, plate, brisket, and shank. Primals from the hindquarter of a carcass include the loin, flank, and round. The loin can be further divided into the sirloin and short loin which are subprimals.



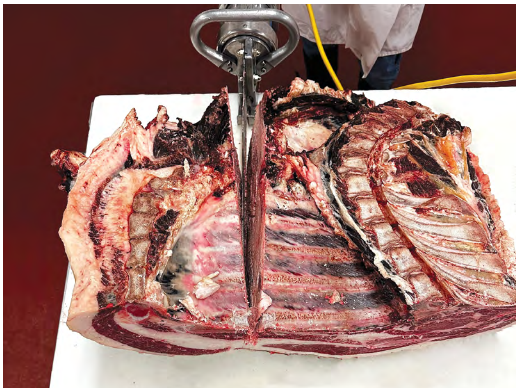
Beef Fabrication

The first step in beef fabrication is the separation of the forequarter and the hindquarter. These can be separated by sawing between the 12th and 13th ribs on the carcass. Once the cut is made 12 ribs should remain in the forequarter, with only one rib remaining in the hindquarter. Occasionally, a beef carcass will have 14 ribs. In that case two ribs will be left in the hindquarter. This is especially common in dairy or dairy cross carcasses.

Forequarter Primal Breakdown

1. Separate the rib and plate from the chuck, brisket, and shank by sawing between the 5th and 6th rib, hugging closer to the fifth rib to keep the rib primal as large as possible. This is important because the rib primal is one of the highest value primals in the carcass.

2. Square off the chuck by removing the brisket and the shank. Make a cut perpendicular to the cut surface, where the rib and plate were removed, at the first cartilage junction of the sternum and about one inch dorsal to the main muscle of the brisket.



3. Separate the brisket and shank at the large seam between the two (indicated by the black line).

4. Separate the rib and the plate by sawing 3 inches ventral to the eye muscle of the rib primal perpendicular to the ribs.

Hindquarter Primal Breakdown

1. Remove kidney fat if present.

2. Peel the flank back by cutting through the seam of fat which connects it to the round and follow ventral to the tenderloin to a point 1 inch ventral to the loin eye muscle. Saw through the remaining rib and remove the flank.

3. Separate the round from the loin approximately 1 inch cranial to the aitch bone and between the 6th and 7th sacral vertebrae.

4. Separate the sirloin from the short loin at the last lumbar vertebrae by a cut made at ⅓ of the length of the last vertebrae from the anterior side.

Individual Primal Fabrication

Chuck

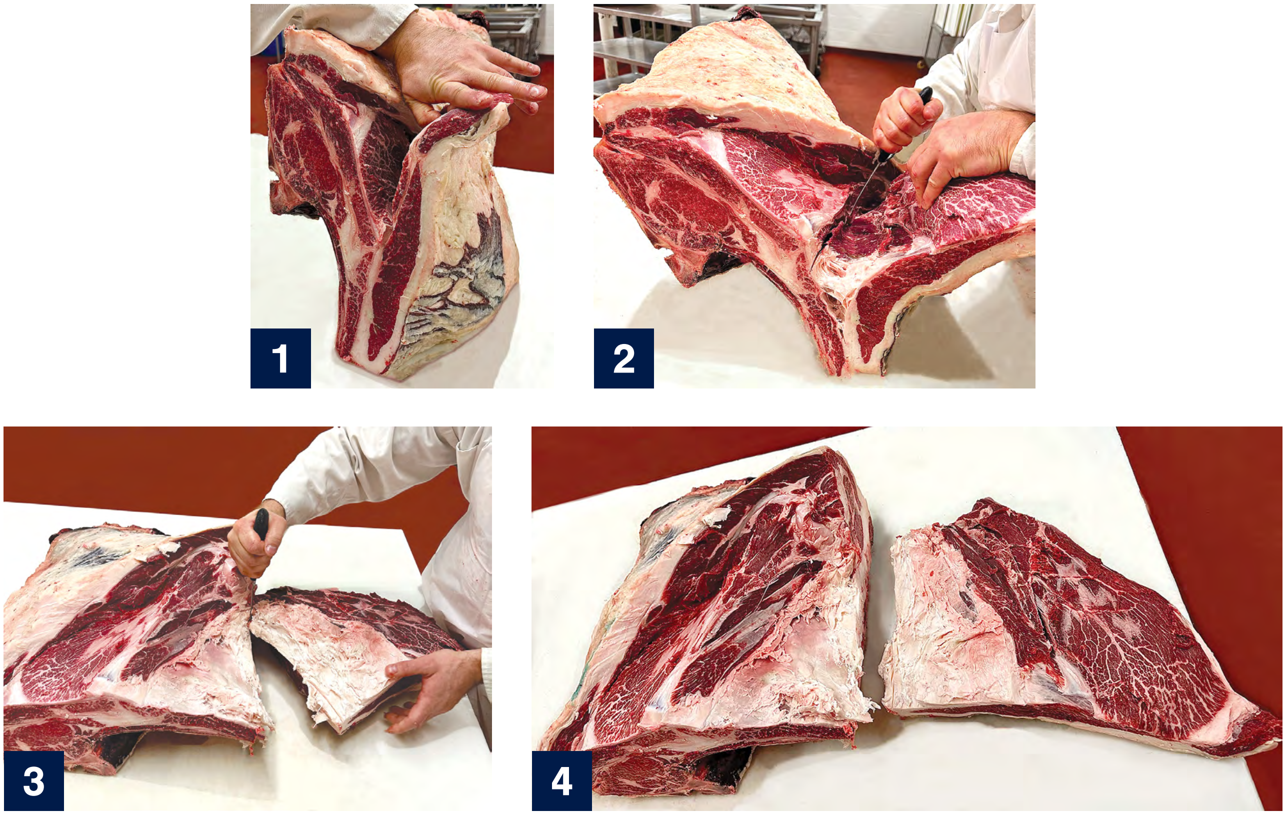
Many different cuts can come from the chuck, including numerous roasts and some quality steaks. Some of the most tender muscles in the entire carcass come from steaks in the chuck (flat iron steak = 2nd most tender cut in the carcass, Denver steak = 5th most tender cut in the carcass).

Removing the Shoulder Clod

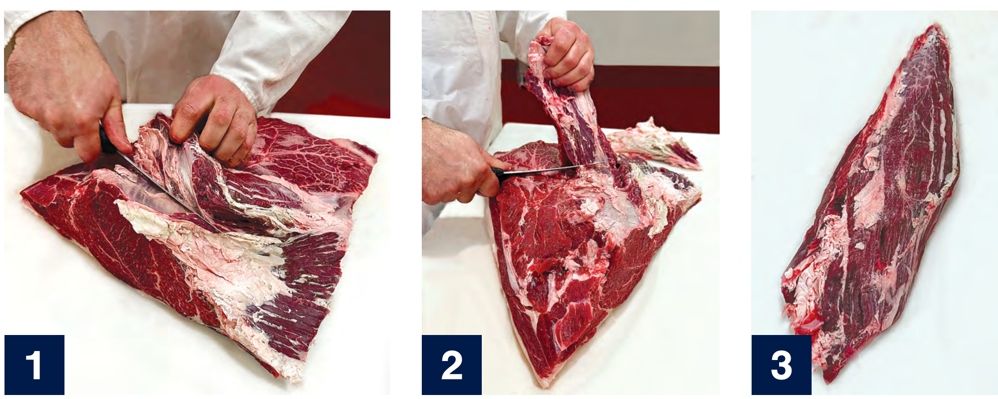
1. Locate the shoulder blade on the posterior portion of the chuck (where it was separated from the rib and the plate). Follow along the shoulder blade with the knife, until it is stopped by the scapular ridge.

2. Turn the knife up at a 90-degree angle and follow the scapular ridge until the top of the knuckle bone is reached.

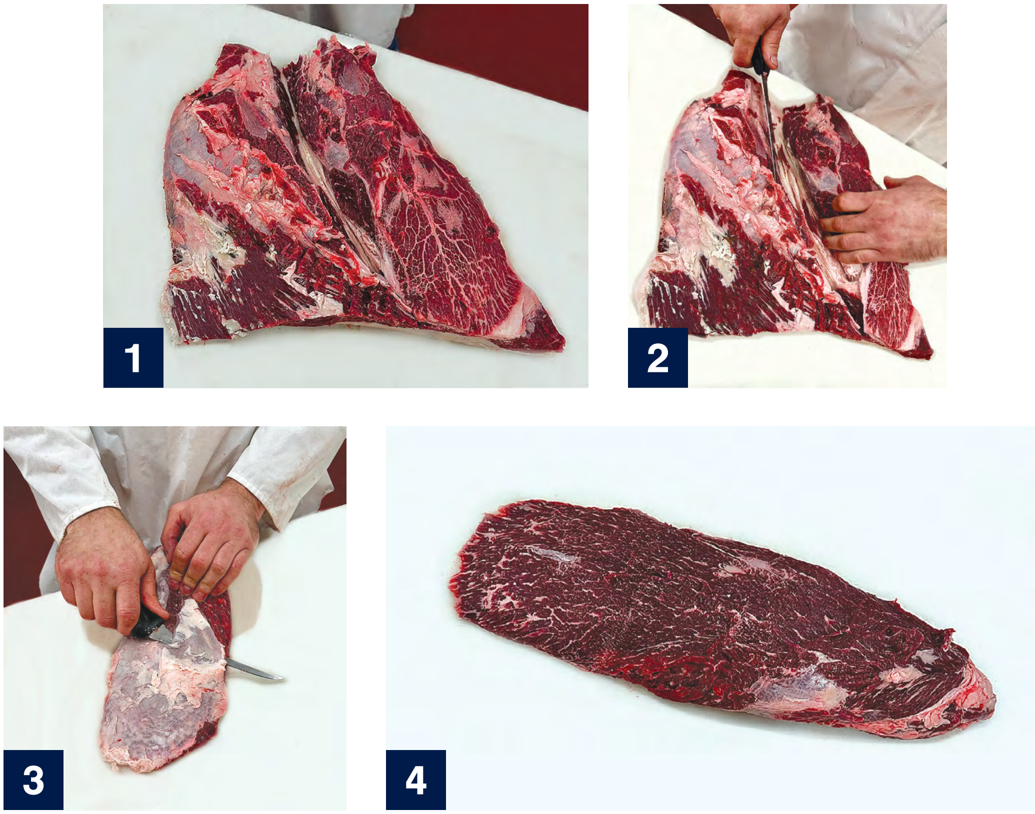
3. Flip the chuck on its side to enable gravity to do majority of the work. Separate the shoulder clod from the remainder of the primal by removing it from the scapula. Once the edge of the scapula is reached, continue peeling the clod following the fat seam until it comes completely off the remainder of the chuck.



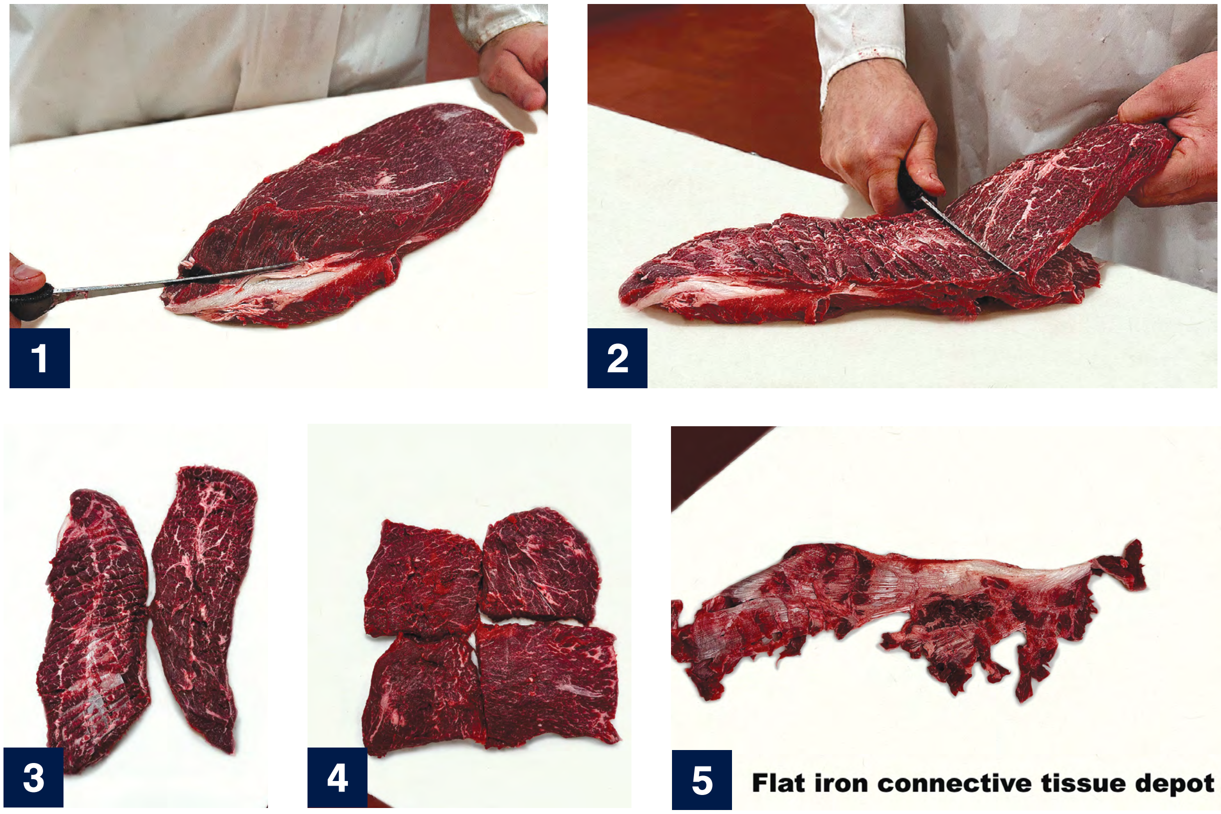
4. Next, remove the petite tender from the clod. Remove external fat and connective tissue.



5. Remove the infraspinatus (flat iron) muscle. Remove silver skin and fat.



6. Fabricate flat iron steaks by following the connective tissue seam in the middle of the muscle with the knife. Cut the meat away from either side of the connective tissue, almost like filleting a fish. Trim all connective tissue off until only muscle remains. Square up the muscle and then repeat steps on the other side of the muscle. Do not leave the connective tissue layer on the cut, it will not cook out and it is very tough.



7. Finally fabricate the remaining piece of the clod (clod heart) into outside chuck roasts.

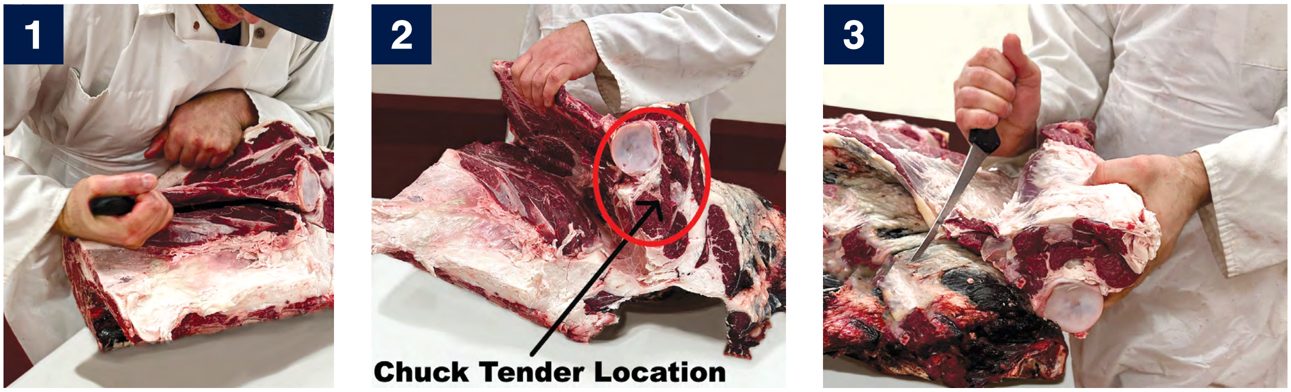
Remove the Knuckle

1. The knuckle is connected with a ball and socket joint between the scapula and the humerus. Cut through the connective tissue which holds the joint together.

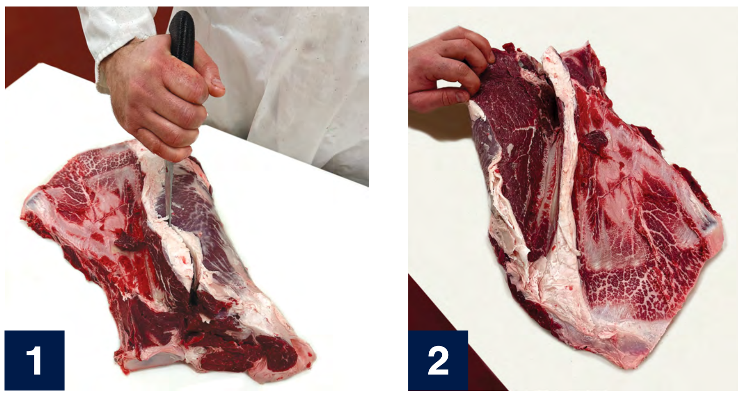
2. Continue to cut straight down to the table to remove the knuckle. The knuckle can then be boned out for trim used in further processing.

Remove the Scapula and Chuck Tender

1. Trace the bottom side of the scapula with the knife. Pull up on the scapula while cutting. Ensure you're following the chuck tender seam while removing the scapula, the chuck tender should come with the scapula.



2. Once separated, the chuck tender can be removed from the scapula. Follow along the ridge of the scapula to separate the meat and bone. Remove excess fat prior to retail.

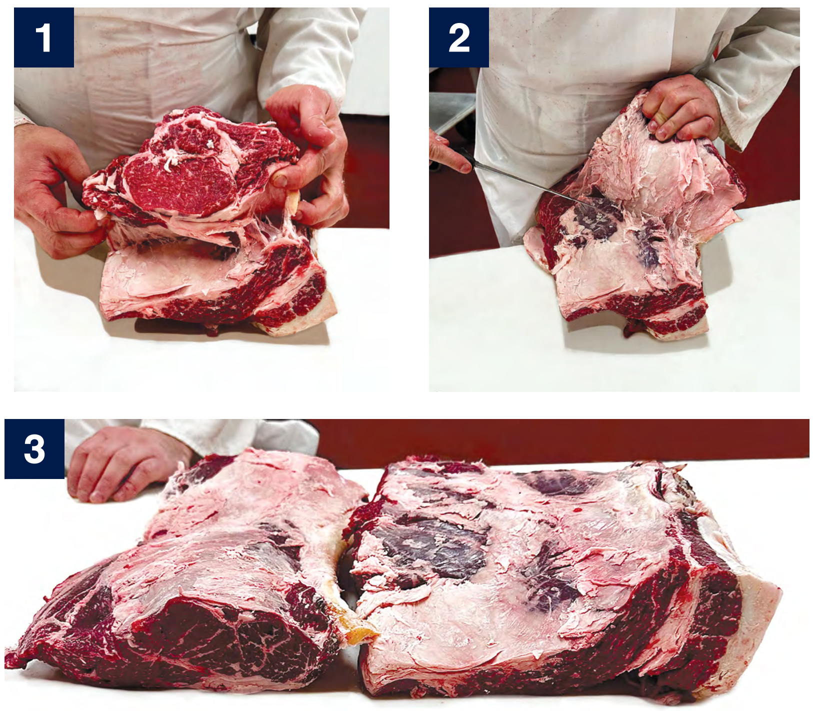


Remove the Chuck Roll

1. Make a straight cut to square off the chuck roll on the anterior side of the first rib. This cut should be deep enough to hit bone.

2. Identify where the ribs begin to flatten off the vertebrae and cut down along the rib bones with a knife, peeling the chuck roll toward the dorsal side while cutting, eventually removing it completely off the feather bones.

3. From the posterior side of the chuck roll, identify the portion that looks like a ribeye. Follow the large fat seam running through the middle of the chuck roll, cut and peel the muscle away, utilizing the large, yellow colored ligament as a starting point. This cut should peel away easily.



4. Remove the thick, yellow ligament. Fabricate two or three 1” Delmonico (chuck eye) steaks from the posterior face closest to the rib. The remainder of the chuck roll is the inside chuck roast or country style ribs. Remove the heavy connective tissue before retail.

5. Returning to the piece the chuck roll was removed from, identify the triangular muscle on the inside. Separate this muscle from the rest of the cut. This is the Sierra cut and it is a good substitute for a flank steak.

6. Remove the fat from the remaining portion of the chuck roll to find the large muscle where Denver steaks come from. This muscle should have numerous "fingers" of fat seams where the muscle fibers change directions. Follow the heavy fat seams below the fingers to separate the Denver cut from the rest of the meat.

7. Cut the muscle in half while following the largest muscle seam to create two pieces with mostly parallel fiber direction.

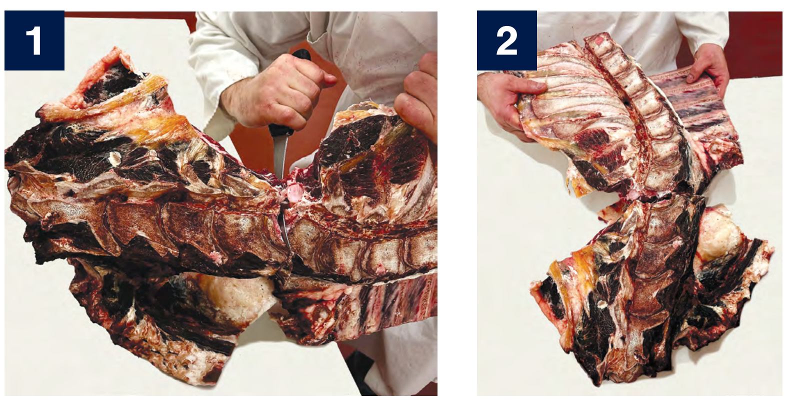
8. Cut Denver steaks perpendicular to the direction of the muscle fibers.

Remove Short Ribs

1. Use a saw to remove the short ribs (circled) from the chuck at the same point the chuck roll was removed.

Remove Neck Bones

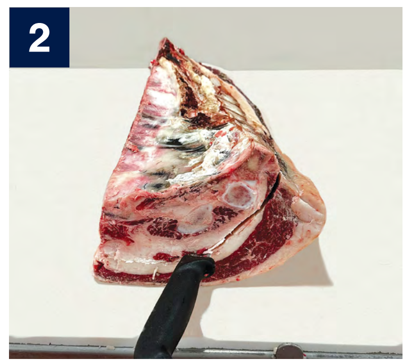
1. Separate the neck bones using a knife or a saw anterior to the first rib. Remove dried meat and fat from the bones. These can be sold whole or cut into smaller sections.



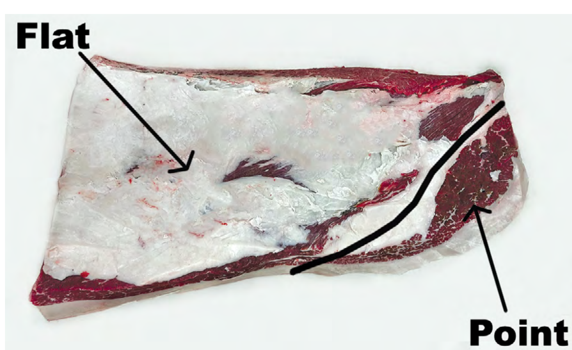
Brisket

The brisket can be sold whole, or in sections. A brisket is comprised of two parts: the point, which is fattier, and the flat, which is leaner and more uniform in thickness.

1. Remove the bone and cartilage located on the face of the brisket. Use the knife to trace around the bone. Focus on not cutting too deep into the meat and remove all the bones. Ensure no cartilage or bone pieces remain on the meat.



2. Trim the fat to desired thickness. From here the brisket can be sold whole or separated into the point and the flat.



Shank

The shank can be trimmed and sold whole, cut into crosscut sections, or boned out for trim.

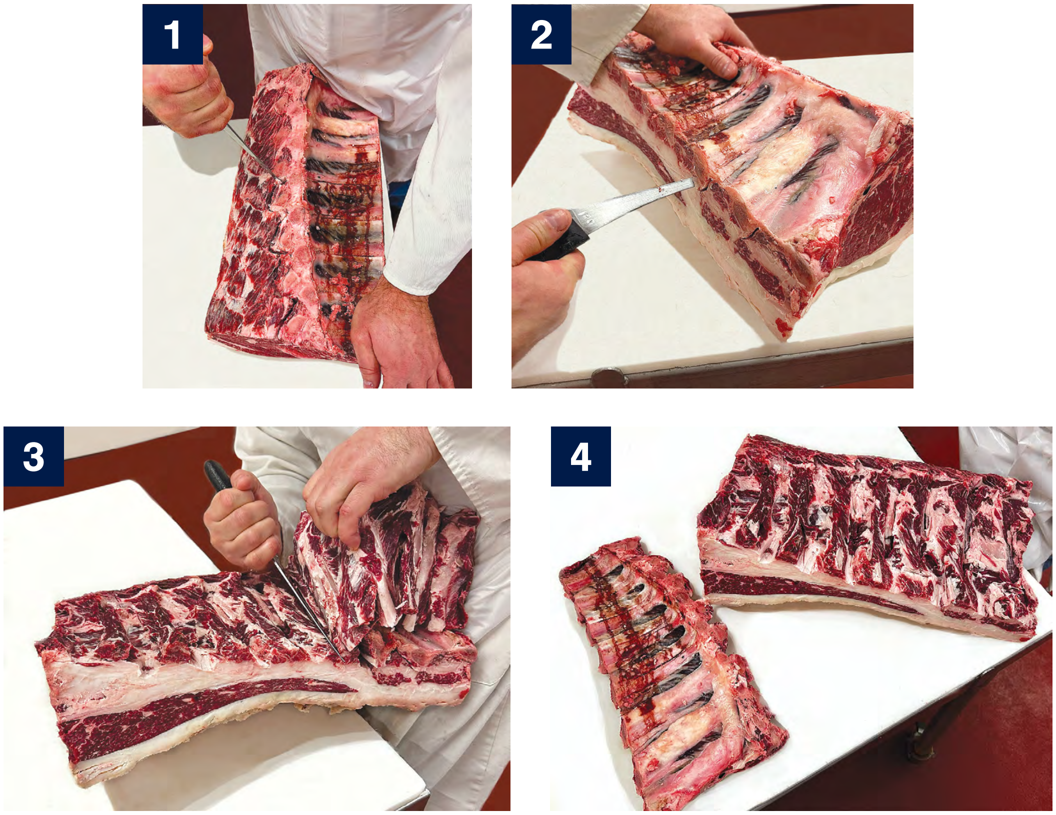
Rib

The rib is generally cut into ribeye steaks or left whole as a prime rib. The rib can be fabricated either bone-in or boneless.

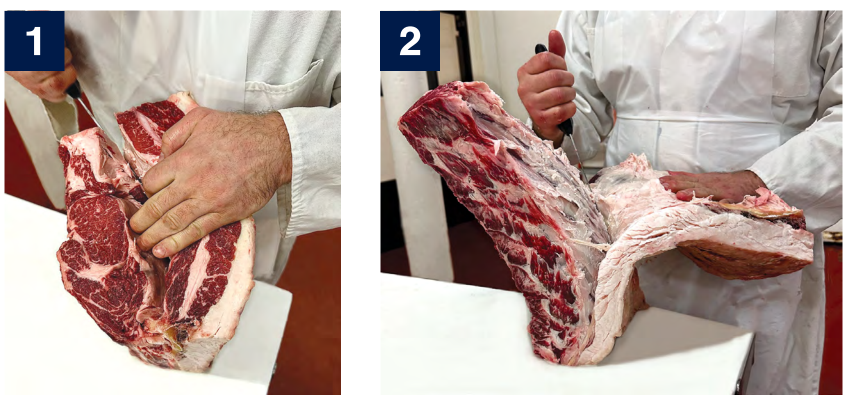
1. Remove the chine bone from the vertebrae. The chine includes the spinal column and part of the surrounding vertebrae. Removing this structure will allow you to remove the feather bones and ribs separately.

2. Remove the feather bones.

3. Remove all the ribs and button bones. Remove the ribs by cutting closely below them, scooping around each rib, leaving them together or taking them out individually. The ribs can be sold as beef ribs or used for trim.



4. Following the seam of the fat cap, remove the secondary muscles from the ribeye roll.



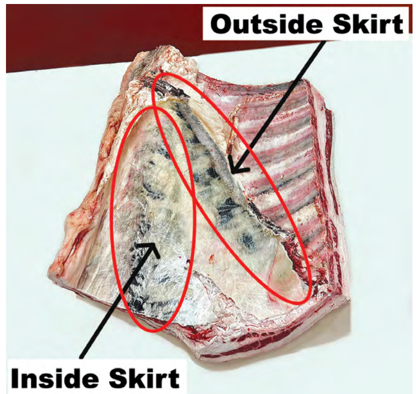
5. Remove the thick yellow ligament that runs along the dorsal edge.

Plate

The plate is comprised of skirt steaks and ribs.

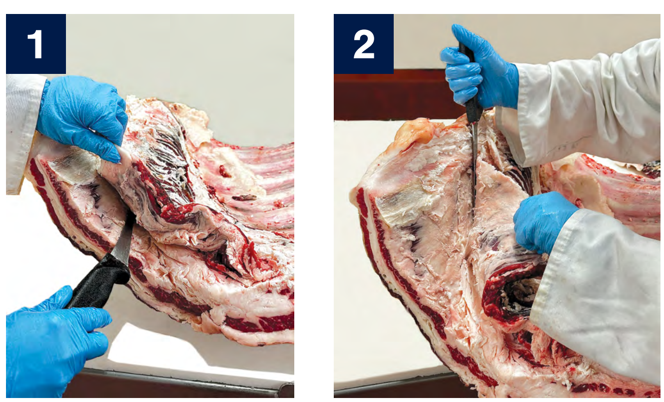
Skirt Steak Fabrication

1. Remove the membrane covering the entire open face of the plate.



2. Remove the outside skirt steak by cutting along the base of the skirt steak where it meets the abdominal wall until it is completely removed. Set this aside.

3. Remove the inside skirt steak. This is the wider of the two skirt steaks and is more firmly attached to the ribs. From the anterior side, locate the outside skirt near the ventral side of the plate. Using your knife follow the heavy fat seam below the muscle to separate it from the ribs.



4. Remove the dried meat, connective tissue, and fat located on the outside of the skirt steaks.

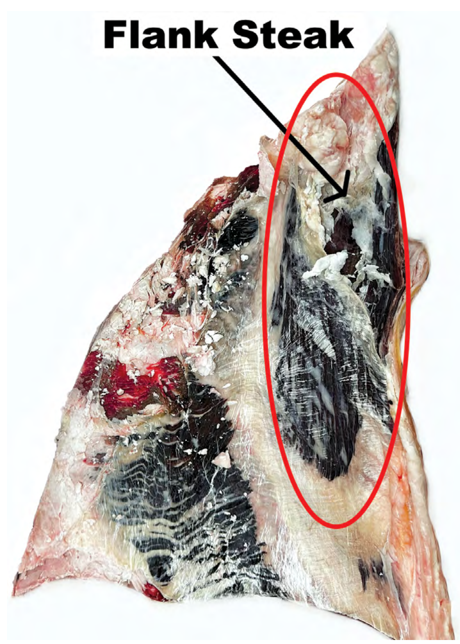
Remainder of Plate Fabrication

1. Separate the rib portion from the sternum. Locate the area on the most dorsal portion of the ribs where the ribs meet the cartilage running along with the sternum. Cut through the cartilage connecting the ribs

   From here there should be two parts of the plate: the rib section, which can be fabricated into beef ribs or boned out and put into trim, and the sternum, which is boned out for trim.

Flank

The primary cut that comes from the flank is the flank steak, the remainder is typically placed into trim for further processing.



1. Start by peeling the membrane off the flank steak muscle. This flank steak is located near the posterior tip of the flank primal on the opposite side of the remaining rib where much of the fat is located.

2. Remove the flank at the fat seam below the muscle. Remove dried meat and fat.

Loin

Short Loin

The short loin is home to numerous valuable and popular steaks like the tenderloin, New York strip, T-bone, and porterhouse. It is important to keep in mind, while all these steaks come from this section of beef, how the subprimal is cut will dictate which steaks can be made. For instance, consumers can either get the New York strip and tenderloin or a T-bone and porterhouse.

Bone-in Loin Fabrication

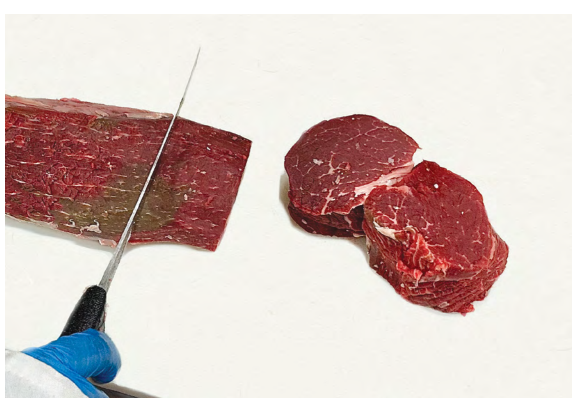
The two cuts from a bone-in short loin include the T-bone steak and the porterhouse. The difference between the two is the size of the tenderloin. The tenderloin on a porterhouse steak will be at least 1.25", and a T-bone is 1.25" or less when measured from the center bone to the edge across the thickest portion of the tenderloin.

1. Trim the external fat layer of the loin to about ¼" thick and cut into steaks of the desired thickness.

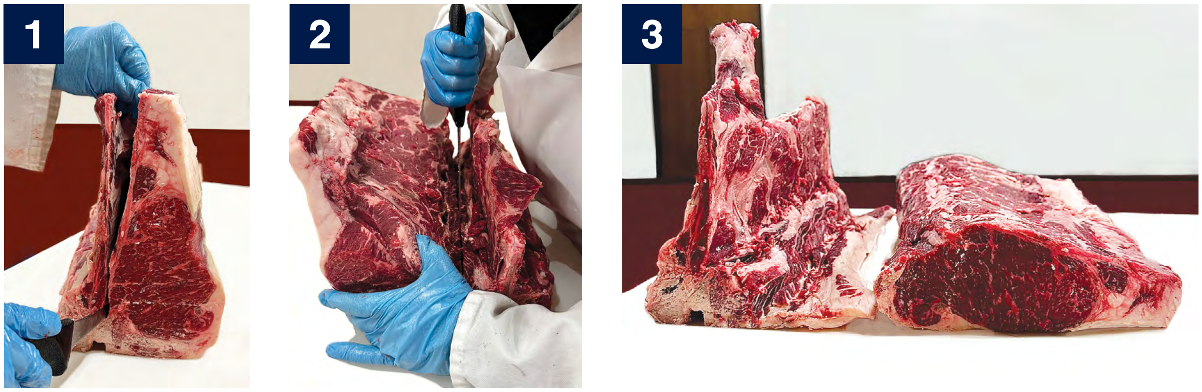
Boneless Loin Fabrication

1. Remove the tenderloin.

2. Trim excess fat and connective tissue from the tenderloin. This cut can be left whole or fabricated into steaks of desired thickness.



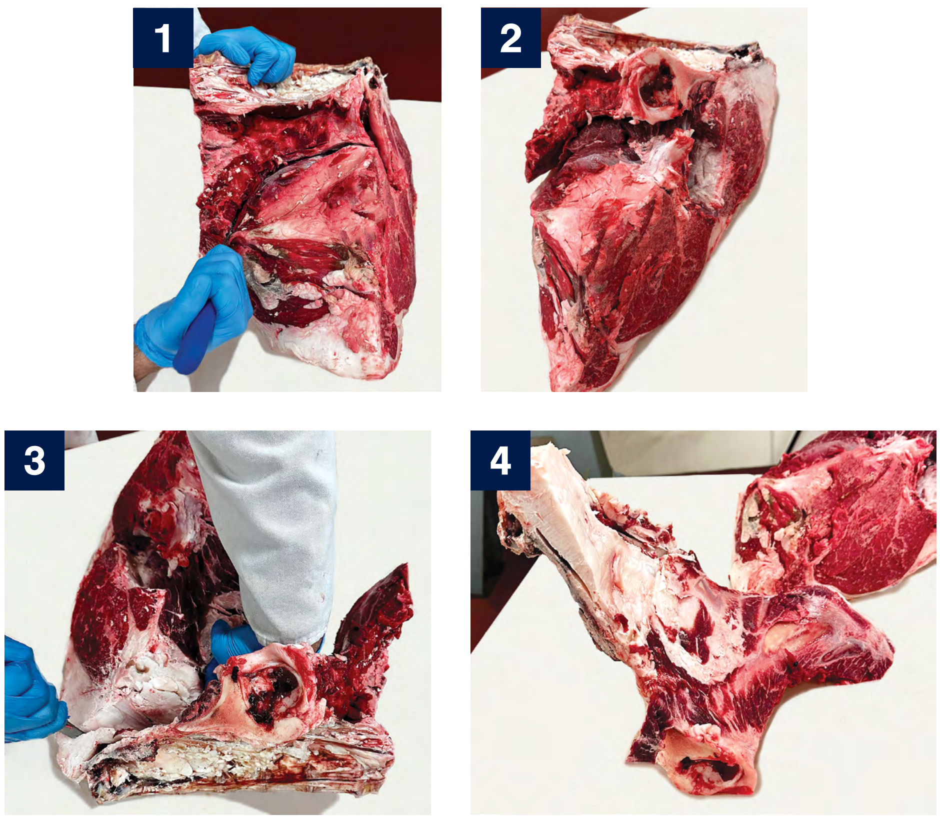
3. Remove the loin eye muscle, also known as the strip loin, by following the spinous process of the vertebrae, peeling the whole muscle back while cutting. The strip loin can be left whole or cut into New York strip steaks of desired thickness.



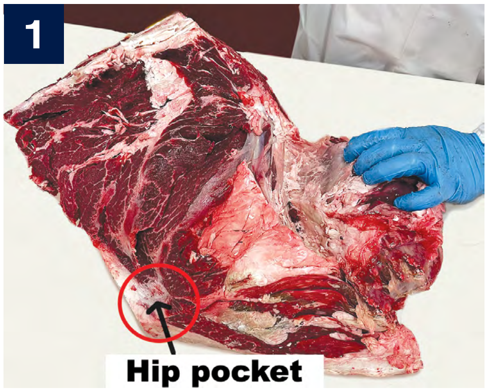
Sirloin

1. Remove the tenderloin if present and cut into steaks as previously described.

2. Use a knife to cut around the pelvis bone to remove it from the subprimal.



3. Locate the posterior side of the sirloin, opposite the hip pocket, identified below. Identify the ball tip, which has a characteristic horseshoe shape muscle in the middle. Remove the ball-tip following the connective tissue seam. This can be left whole as a roast or fabricated into ball-tip steaks of desired thickness.



4. Remove the tri-tip from below the location where the ball-tip was removed, trimming away any fat to visualize the seam. The seam between the top sirloin and the tri-tip is thin, use caution when making this cut as it is easy to cut into either muscle. Remove excess fat and connective tissue from the tri-tip prior to retail.

5. Identify the center-cut top sirloin butt. It is the largest muscle left on the sirloin. Remove the center-cut top sirloin butt from the cap muscles below by following the fat seam.

6. To fabricate steaks, identify the side of the center-cut sirloin with the heavy connective tissue visible in the middle. Cut the center-cut sirloin top butt into thirds perpendicular to the side with the connective tissue. Remove cap muscles, fat, and connective tissue from each third and fabricate into steaks of the desired size, cutting perpendicular to the muscle fiber direction.

7. The Coulotte is the last cut to remove from the sirloin and it is located beneath the center-cut sirloin. Trim away the remaining fat.

Round

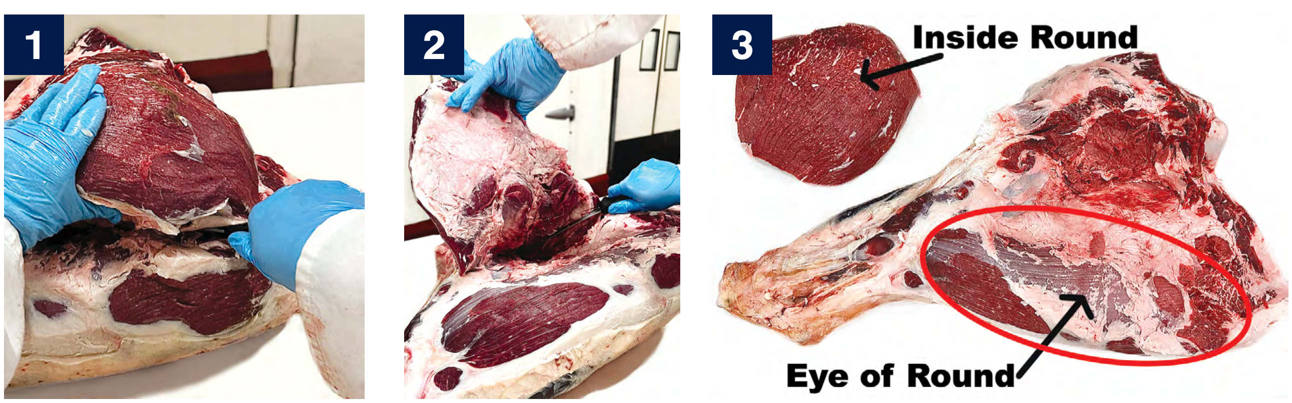
Remove the Aitch bone

1. Remove the aitch bone. This bone lies several inches below the cut surface. Locate the ball and socket joint where the aitch bone connects to the femur.

2. Separate the aitch bone from the head of the femur by cutting through the connective tissue ligament holding the ball and socket structure together. Once the ligament is severed, the aitch bone should be removed easily.

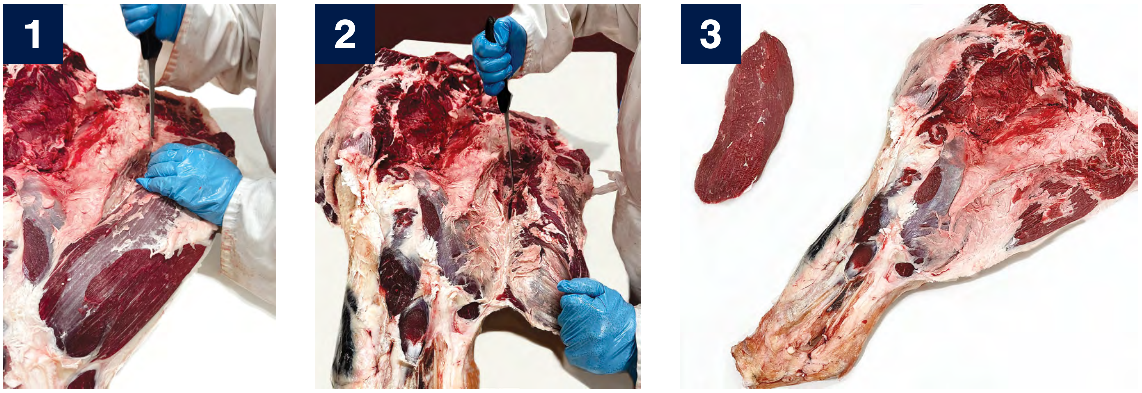
Fabricating the Inside (Top) Round

1. The inside round is the large muscle on the top of the round. Remove the muscle at the heavy fat seam below the muscle, if seams are not visible, trim away fat on the exterior of the round until it is found. Peel the muscle back while cutting through the connective tissue and fat. Remove the cap muscle from the top of the inside round and remove any remaining connective tissue and fat.



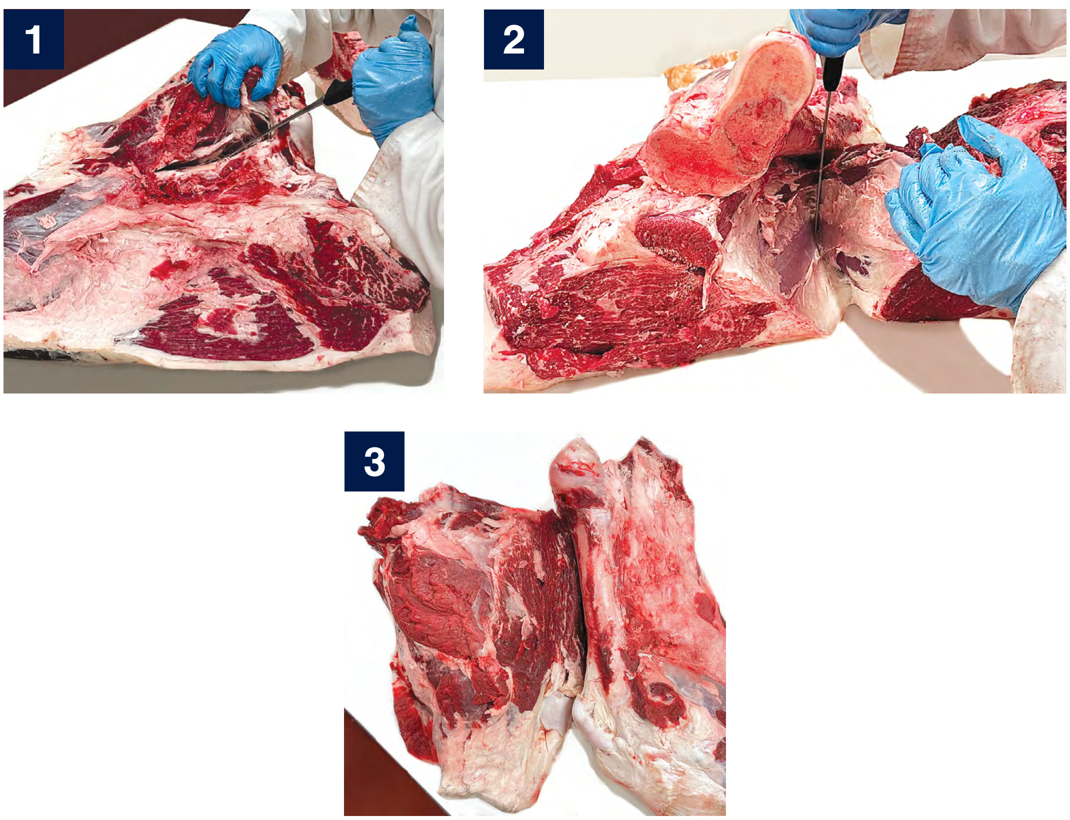
Remove the Eye of Round

1. Locate the eye of round muscle, the long cylindrical muscle that lies under the inside round and separate it from the rest of the round at the fat seam. Once removed, trim the eye of round of external fat.

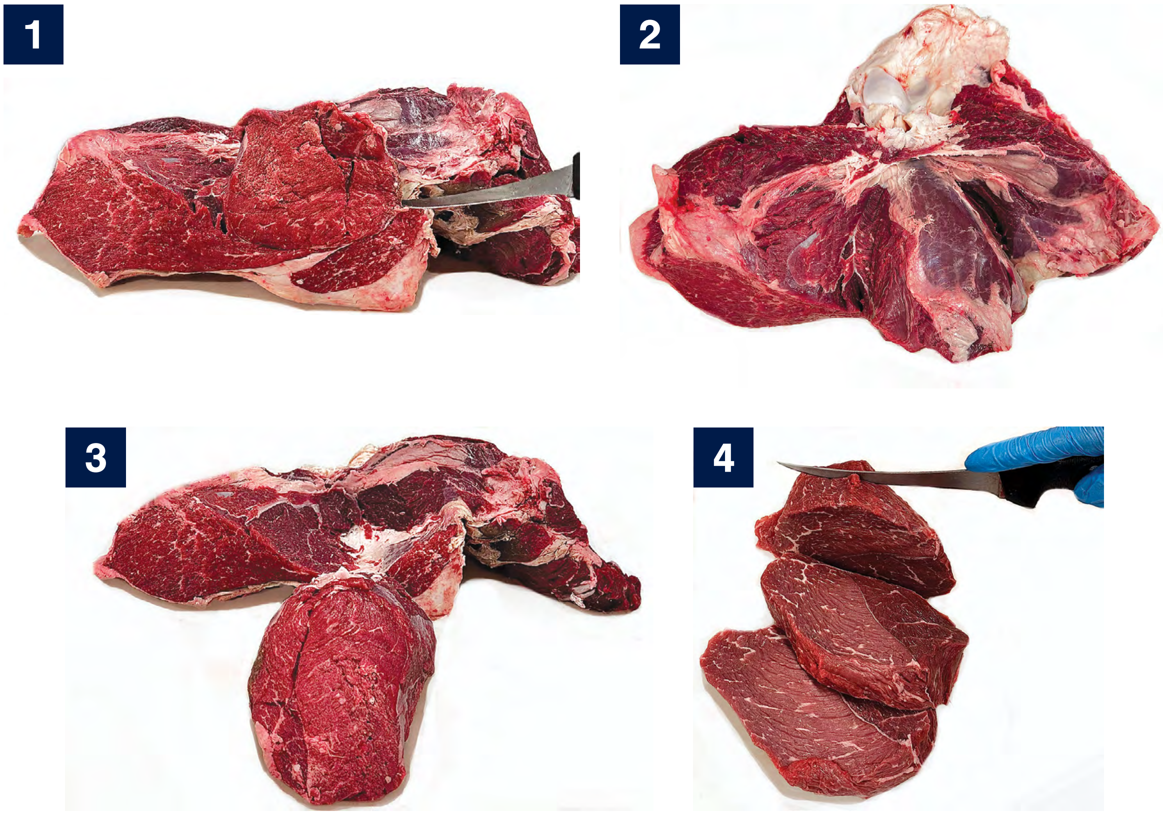


Remove the Knuckle

1. Looking at the face of the round, identify the knuckle. It looks like the ball tip described in the sirloin. Remove the knuckle from the femur by cutting along and under the shaft of the femur bone with the knife. A heavy seam of connective tissue lies below the femur. Follow that connective tissue seam towards the table and towards the shank to the end of the knuckle and remove it from the round.



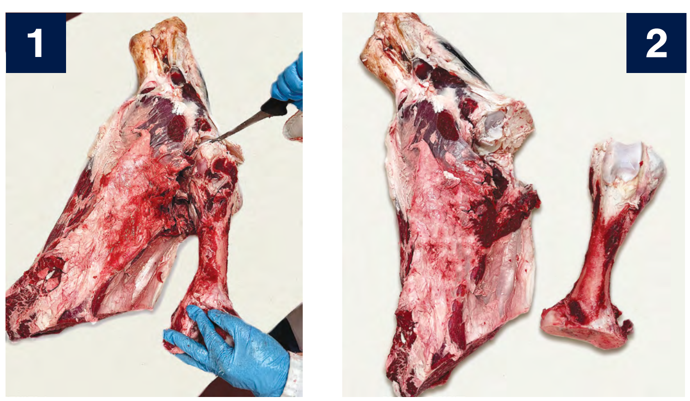
2. Follow the horseshoe shaped connective tissue to remove the center portion of the knuckle. Remove connective tissue around the exterior and cut into steaks.



3. The remainder of the knuckle can be fabricated into stew meat by removing connective tissue and cutting into 1" cubes.

Remove the Femur

1. Separate the hinge joint by cutting through the ligament holding it in place. Long bones, such as the femur, have value as marrow or soup bones.



Fabricate the Outside (Bottom) Round

1. Locate the seam between the heel that surrounds the remaining bones and the outside round. Follow along the seam of the heel muscle to separate it from the outside round.

2. Trim off the connective tissue and fat from the outside round.

3. The outside round is triangular shaped and tapers to one end. The tapered end is the rump roast. Cut the rump roast to the desired size. Portion the remaining outside round to roasts.

4. The remainder of the round can be fabricated into trim.

Beef Carcass Yield

How much meat will a beef carcass yield? Often consumers are disappointed by the amount of meat they receive from a beef animal compared to the live weight of the animal. There are a number of reasons carcass yield is much lower than live weight and these factors are explained in depth in the Factors that influence carcass yield section. Beef animals generally have a dressing percentage of 60-65%. Additionally, weight lost during chilling, known as shrink, is about 2-5%. Then depending on the choice of bone-in or boneless cuts, cutting yield from the carcass will be 60-70% of carcass weight. The actual yield can range from 50-75% of the hot carcass weight or around 25-30% of the live weight (Jackson, 2022; SDSU, 2022).

Example

- **Live weight:** 1400 lbs.
- **Dressing percentage:** 63%
- **Shrink:** 3%
- **Boneless cuts:** 62%
- **Retail yield:** 1400 lbs. x 63% = 882 lbs. x 97% = 855.5 lbs. x 62% = 530 lbs.

Approximate Percentages of Cuts from a Fed Steer*

Location and Type of Cut (Boneless Carcass)	Approximate Yield (% of carcass weight)
Lean Trim	20-25%
Chuck: Roasts and Steaks	10-12%
Round: Roasts and Steaks	10-12%
Loin and Rib: Steaks	10-12%
Fat	20%
Bone	15%

*These are approximate numbers, carcasses can vary. Chart is adapted from SDSU Extension *How much can you expect from a fed steer?*

Common Names of Beef Cuts

There are many different names for cuts within a beef carcass. It is not uncommon for names to be different based on geographic location. Because of this, consumers don't always know the cut they are trying to request. Here is a compiled table of various names for different beef cuts in the United States.

Cuts from the Chuck	Alternative Names
Blade Chuck Roast	Beef Pot Roast, Blade Chuck Pot Roast, Bone-In Chuck Arm Pot Roast, Chuck Pot Roast, Chuck Blade Pot Roast, Chuck Roast 1st Cut, Chuck Roast Blade Cut, Shoulder Pot Roast
Blade Chuck Steak	Deluxe Blade Steak, Blade Steak 1st Cut, Chuck Steak, Blade Eye, Bottom Blade, Chuck Arm Steak
7-Bone Chuck Roast	7-Bone Pot Roast, 7-Bone Roast, Chuck Arm Pot Roast, Bone-In Chuck Blade Roast, Bone-In Pot Roast, Center Cut Pot Roast, Chuck Roast Center Cut
7-Bone Chuck Steak	7-Bone Steak, Chuck Steak
Chuck Arm Roast	Arm Pot Roast, Arm Roast, Boneless Chuck Roast
Inside Chuck Roast	Chuck Eye Roll, Chuck Eye Roast, Country Style Ribs, Chuck Center Roast, America's Beef Roast, Inside Chuck Roll
Chuck Eye Steak	Delmonico Steak, Chuck Filet, London Broil, Shoulder Steak, English Steak, Boneless Bottom Chuck Steak, Poor Man's Ribeye
Outside Chuck Roast	Shoulder Clod Roast, Clod Heart, Shoulder Center, Shoulder Clod Arm Roast, Arm Roast, Pot Roast, English Roast
Shoulder Steak	Arm Steak, English Steak, Clod Steak, London Broil, Chuck Steak
Ranch Steak	Chuck Center Steak, Arm Steak, Ranch Cut, Shoulder Center Steak, Center Cut Chuck Steak
Flat Iron Steak	Book Steak, Butler Steak, Top Chuck Steak, Lifter Steak, Petite Steak, Top Blade Steak, Oyster Blade, Feather Steak, Blade Steak
Sierra Steak	Chuck Flank, Sierra Cut
Denver Steak	Under Blade Steak, Boneless Short Rib, Bottom Chuck Steak, Denver Cut, Under Blade Center Steak
Short Ribs	Beef Ribs, Braising Ribs, English Style Short Ribs, Flanken Style Short Ribs, Korean Short Ribs, Chinese Short Ribs, Asian Style Short Ribs
Boneless Short Ribs	English Short Ribs, Middle Ribs, Braising Ribs
Petite Tender	Shoulder Tender, Tender Griller, Teres Major, Butchers Steak, Petite Tender Medallions, Shoulder Tender Medallions
Chuck Tender Roast	Chuck Filet, Scotch Tender, Medallion Pot Roast, Mock Tender
Chuck Tender Steak	Fish Steak, Chuck Filet, Mock Tender Steak, Chuck Clod Tender, Scotch Tender
Chuck Neck Roast	Neck Bones, Soup Bones

Cuts from the Plate	Alternative Names
Hanging Tender	Hanger Steak, Hanging Tenderloin, Butchers Steak, Butchers Cut, Onglet, Bistro Steak
Skirt Steak	Boneless Diaphragm, Fajita Meat, Fajita Steak, Inside Skirt Steak, Outside Skirt Steak, Philadelphia Steak, Romanian Steak, Tex-Mex Skirt, Entraña, Arrachera
Short Ribs	Flanken Style Ribs, Short Plate Ribs, Dino Ribs

Cuts from the Rib	Alternative Names
Ribeye Roast	Newport Roast, Prime Rib, Rib Roast, Standing Rib Roast, Beef Rib, Ribeye Roll, Boneless Rib Roast
Ribeye Steak	Cowboy Steak, Beauty Steak, Ribeye Roll Steak, Rib Steak, Ribeye Filet, Spencer Steak, Market Steak, Entrecôte, Scotch Fillet, bone-in Ribeye, Prime Rib Steak, Boneless Ribeye
Tomahawk Steak	Bone-In Ribeye
Ribeye Cap Steak	Ribeye Cap, Spinalis Dorsi
Ribeye Cap Roll	Calotte Steak, Deckle Steak, Ribeye Cap, Spinalis Dorsi
Back Ribs	Beef Back Ribs, Beef Riblets, Dinosaur Ribs, Finger Ribs, Rib Bones, Beef Ribs
Short Ribs	Beef Ribs
Blade Meat	Lifter Meat, Cap and Wedge Meat

Cuts from the Brisket	Alternative Names
Brisket Flat	Beef Brisket Middle Cut, Brisket Center Cut, Brisket First Cut, Brisket Front Cut, Brisket Nose Cut
Brisket Point	Brisket Nose Cut
Brisket (Whole)	Point End Brisket, Packer Brisket
Cuts from the Shank:	Alternative Names:
Cross Cut Shank	Center Beef Shank, Cross-Cut Shank

Cuts from the Short Loin	Alternative Names
Porterhouse Steak	King Steak, Porter House, 1st Cut Porterhouse
T-Bone Steak	T-Bone, Club Steak
Strip Loin	Strip Loin Roast, Top Loin Roast, New York Strip Roast, Short-Cut Beef Loin
Strip Steak	New York Strip, Kansas City Strip, Ambassador Steak, Club Steak, Kansas City Steak, Shell Steak, Strip Loin Steak, Top Loin Steak, Country Club Steak, Hotel Cut Steak, Hotel Style Steak, Veiny Steak
Strip Petite Roast	Top Loin Petite Roast, Center Cut Striploin Roast, Manhattan Filet
Strip Filet	Baseball Cut Strip Filet, Manhattan Filet, Strip Steak-Split, Top Loin Filet, Club Cut
Tenderloin (Whole)	Chateaubriand, Center Cut Tenderloin Roast, Filet Mignon Roast, Whole Tenderloin
Tenderloin Steak	Tenderloin, Filet Mignon, Filet Steak, Fillet de Boeuf, Tenderloin Medallions, Tournados, Chateaubriand
Tenderloin Butt	Butt Tender, Tenderloin Head

Cuts from the Sirloin	Alternative Names
Top Sirloin Steak	Boneless Sirloin Butt Steak, Top Butt Steak, Top Sirloin Butt Center Cut Steak, Top Sirloin Steak Cap Off, Center Cut Sirloin, Top Sirloin, Sirloin Butt Steak, New York Sirloin Steak
Top Sirloin Petite Roast	Center Cut Top Sirloin Roast
Top Sirloin Filet	Baseball Cut, Center Cut Top Sirloin Steak, Top Sirloin Butt Steak
Coulotte	Picahna, Top Sirloin Cap, Top Sirloin Cap Steak, Rump Cap, Rump Cover
Coulotte Steak	Top Sirloin Cap Steak, Picahna Steak
Top Sirloin Butt Center Cut	Center Cut Top Butt, Top Sirloin Heart
Tri-Tip	Bottom Sirloin Roast, Triangle Roast, Newport Roast, Santa Maria Roast, California Cut, Poor Man’s Brisket, Bottom Sirloin Butt, Knuckle Cap, Triangle Tip
Tri-Tip Steak	Newport Steak, Triangle Steak, Santa Maria Steak

Cuts from the Sirloin	Alternative Names
Petite Sirloin Steak	Balltip Steak, Sirloin Steak, Hobo Steak
Sirloin Tip Center Steak	Breakfast Steak, Knuckle Steak, Round Tip Center Steak, Sandwich Steak, Tip Steak, Sirloin Tip Medallion Steak
Sirloin Bavette	Bottom Sirloin Bavette, Bottom Sirloin Flap, Sirloin Flap, Bottom Sirloin Butt Flap, Flap Meat, Butcher's Cut, Faux Hanger
Sirloin Bavette Steak	Bottom Sirloin Bavette Steak, Bottom Sirloin Flap Steak, Flap Steak, Flap Meat, Bistro Steak
Petite Sirloin Ball Tip	Ball Tip Roast, Petite Sirloin Roast, Sirloin Roast

Cuts from the Flank	Alternative Names
Flank Steak	Beef Flank, Flank Steak Filet, Jiffy Steak, Plant Steak, London Broil, Bavette, Arrachera

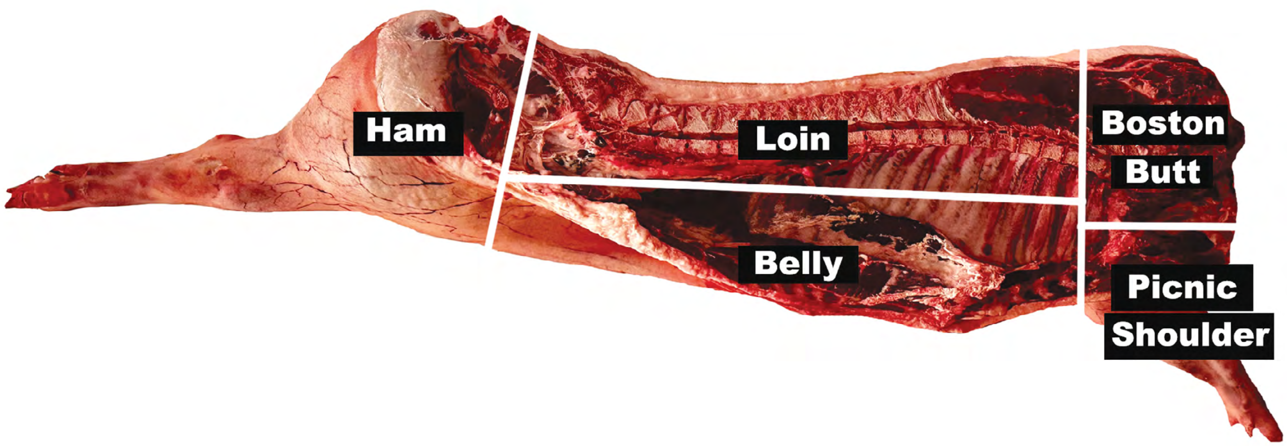
Cuts from the Round	Alternative Names
Steamship Roast	Baron of Beef, Whole Round
Bottom Round Flat	Outside Round Roast, Bottom Round Pot Roast, Bottom Round Oven Roast, Rump Roast, Round Roast, Round Tip Roast, Silverside Round, Bottom Flat, Gooseneck Round, Manhattan Roast
Rump Roast	Diamond Cut Roast, Manhattan Roast, Round Roast, Bottom Round Oven Roast, Bottom Round Pot Roast
Bottom Round Steak	Outside Round Steak, Western Griller, Western Steak, Knuckle, Western Tip Steak, Griller Steak
Eye of Round Roast	Round Eye Pot Roast, Eye of Round
Eye of Round Steak	Round Steak, Round Eye Steak, Breakfast Steak, Sandwich Steak, Wafer Steak, London Broil, Eye Steak
Sirloin Tip Roast	Ball Tip Roast, Crescent Roast, Knuckle Peeled, Knuckle Roast, Round Tip Roast, Sirloin Tip Center Roast, French Roll Roast, Barbeque Roast
Sirloin Tip Center Steak	Breakfast Steak, Knuckle Steak, Round Tip Center Steak, Tip Steak, Sandwich Steak, Sirloin Tip Medallion Steak
Sirloin Tip Side Steak	Breakfast Steak, Round Sirloin Tip Side Steak, Sirloin Tip Eye Steak
Sirloin Tip Steak	Breakfast Steak, Knuckle Steak, Round Tip Steak, Sandwich Steak, Tip Steak, Ball Tip Steak, Beef Sirloin Tip, Minute Steak
Sirloin Tip Side Roast	Sirloin Tip Roast
Top Round Roast	Inside Round Roast, Inside Round, London Broil, Round Roast, Top Round Roast Cap Off, Top Round Roast Cap On, Top Side, Top Round First Cut, Top Butt, Baron of Beef
Top Round Steak	Inside Round Steak, London Broil, Top Round Steak Cap Off, Top Round Steak Cap On, Top Round Steak Cap Off, Breakfast Steak, Sandwich Steak, Butterball Steak
Top Round Cap	Inside Round Cap
Inside Round	Top Round Cap Off, Inside Round Cap Off
Inside Round Front Side Muscle	Round Petite Tender, Top Round Front Side Muscle
Inside Round Front Side Steak	Round Petite Tender Steak, Top Round Front Side Steak
Santa Fe Steak	Top Round Cap Steak, Inside Round Cap Steak

Pork

Pork primals, pork fabrication, and yield differences will be discussed in this section. Also included is a table with different names of common pork cuts.

Pork Primals

Pork carcasses can be broken down into five primals including the Boston butt, picnic shoulder, loin, belly, and ham. The primals are indicated on the image below.

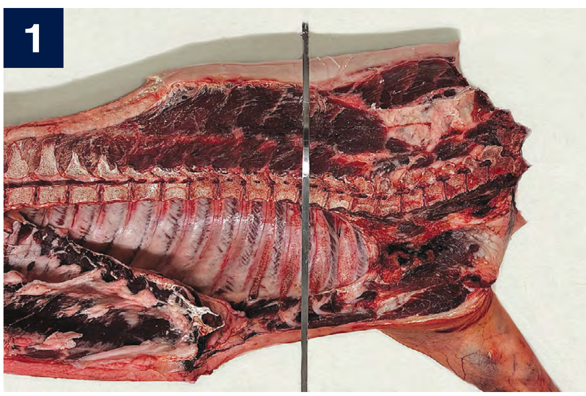


Pork Fabrication

Primal Fabrication

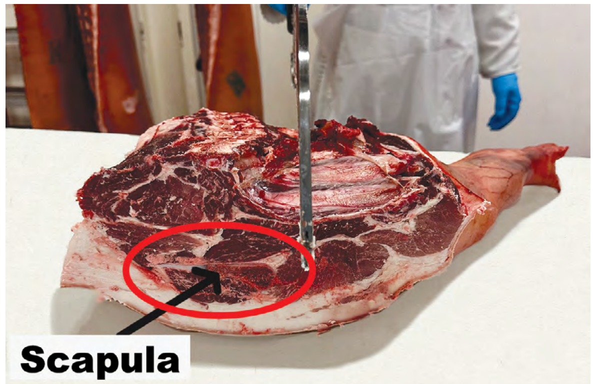
1. Remove the feet above the front leg joint and the hock.

2. Separate the Boston butt and the picnic shoulder from the loin and belly between the 2nd and 3rd rib, hugging closer to the second rib.

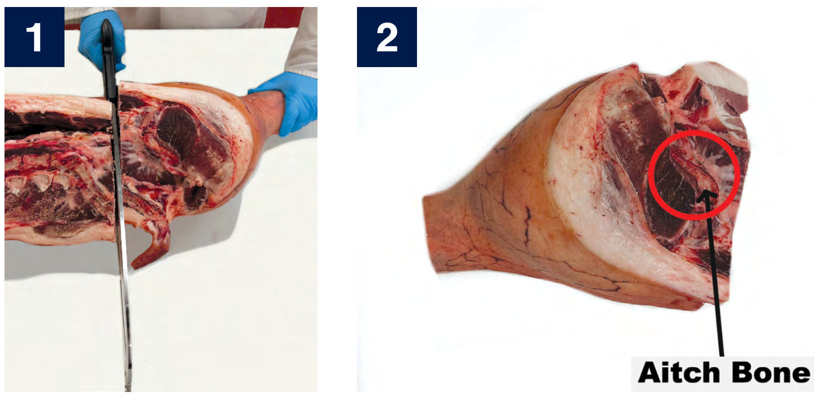


3. Remove the neck bones from the shoulder section. Place the knife under the ribs and follow the bone to remove the ribs and vertebrae in one piece.

4. Separate the Boston butt and the picnic shoulder by placing the saw 1” ventral to the scapula and cutting completely through the shoulder section.



5. Separate the ham from the belly and loin by first identifying the aitch bone. Cut 1.5-3” cranial to the aitch bone perpendicular to the back leg.



6. Separate the loin and the belly by identifying the tenderloin that runs under the vertebrae from the ham end of the loin. Cut alongside the tenderloin parallel to the vertebrae until you hit rib bones. Identify where the first remaining rib on the shoulder end meets the vertebrae. Connect that point with the cut made from the ham end using a saw to separate the loin and belly.

Individual Primal Fabrication

Boston Butt

1. Remove the skin (if applicable).

2. Square up the primal by removing the jowl located on the anterior end. Ensure the lymph node is removed from the fat pocket in the jowl.

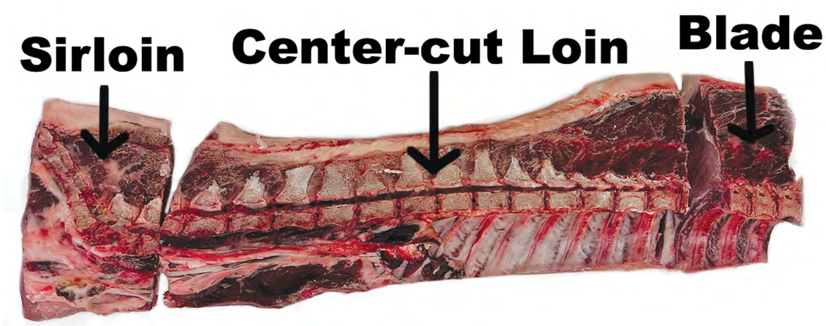
3. Trim the fat cap to ¼" thick. The Boston butt can be sold whole as a roast, further processed by smoking and making pulled pork, or it can be fabricated into blade steaks.

Picnic Shoulder

The picnic shoulder can be sold skin on or off. It is typically sold as a picnic roast or turned into trim for further processing.

Loin

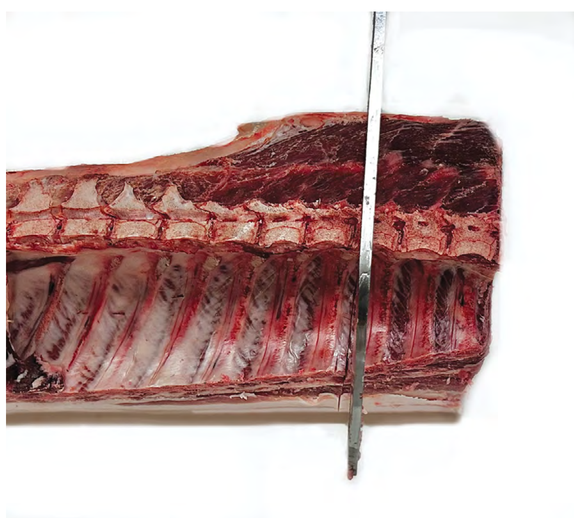
The main cuts from the loin include chops, back ribs, and roasts. The pork loin can be fabricated bone-in or boneless. The loin is separated into three parts as depicted in the image below: blade portion (anterior), center-cut loin, and sirloin portion (posterior).



Separating the Loin into Subprimal Sections

1. Remove the skin (if applicable), hanging tender, and the diaphragm.

2. Remove the blade portion of the loin by identifying the last (most posterior) rib and count 8 ribs towards the shoulder end. Saw between the 8th and 9th rib from the posterior end of the loin.



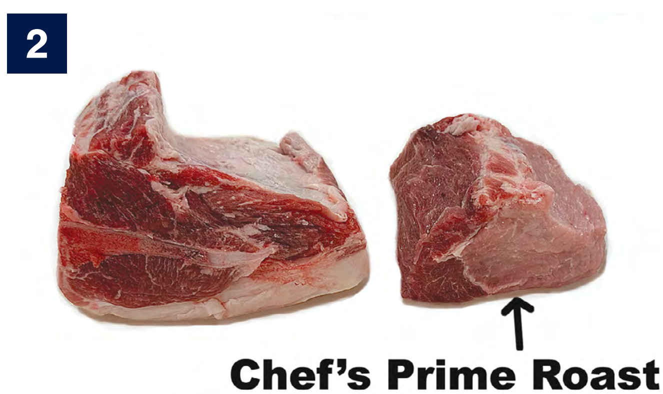
3. Remove the sirloin portion from the center-cut portion of the loin by locating the last lumbar vertebrae (which is the last vertebrae parallel to the loin) and saw it in half, perpendicular to the length of the loin.

Blade Portion Fabrication

The blade portion can be fabricated into bone-in or boneless cuts.

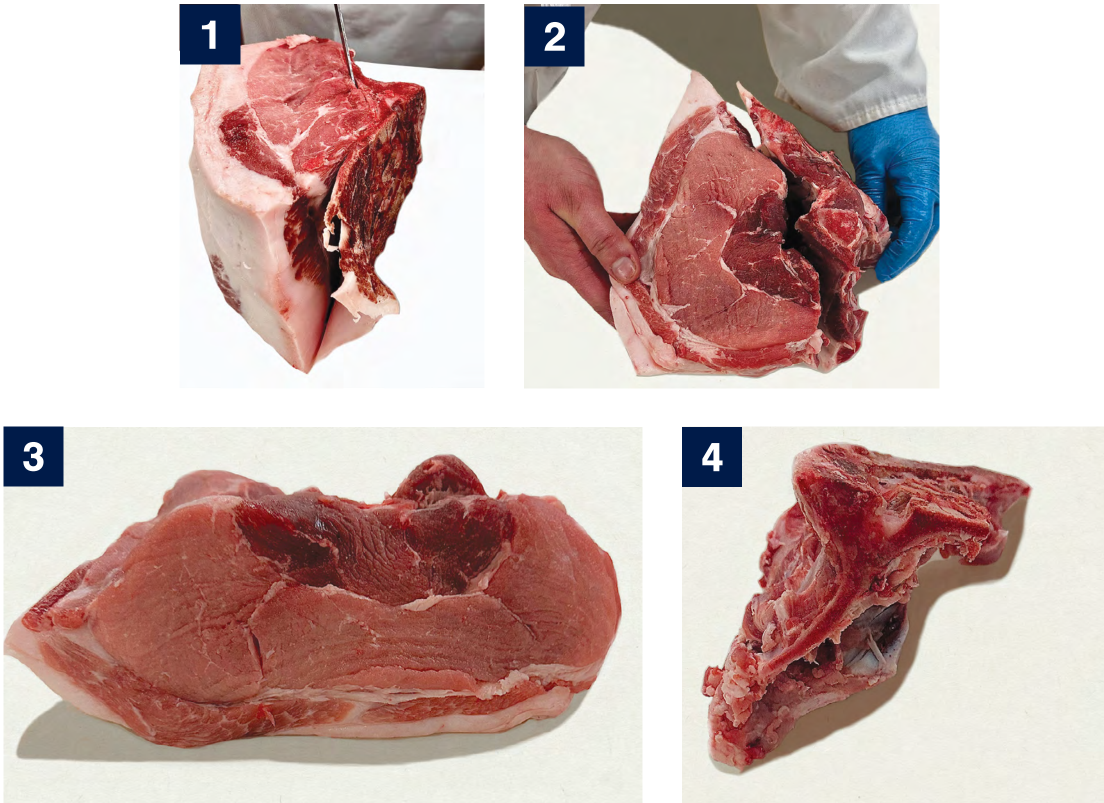
1. Remove the backbone and ribs.

2. Peel the loin eye following the heavy seam of fat to separate it from the accessory muscles. The chef's prime can be left as a roast or further fabricated into boneless blade chops.



Sirloin Portion Fabrication

1. The sirloin can be left bone in to make sirloin chops. If boneless cuts are desired, remove the backbone. The boneless portion can be left as a roast, cut into sirloin cutlets, or be fabricated into trim for further processing.

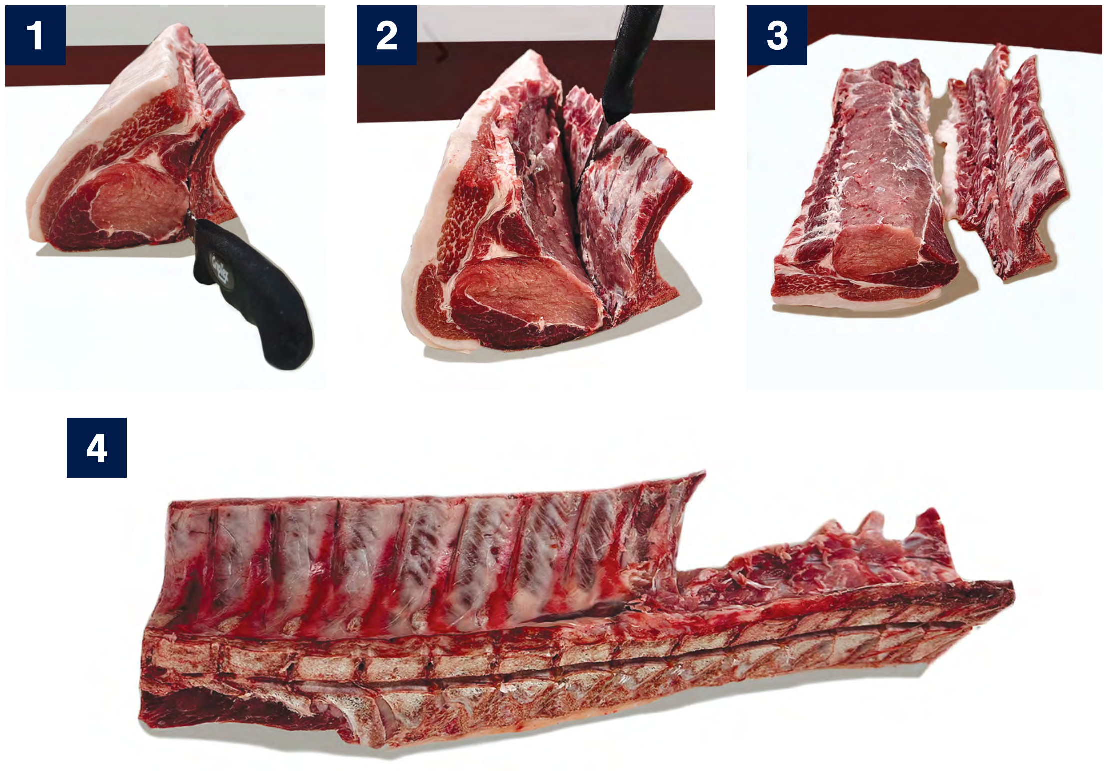


Center-Cut Loin Fabrication

The center-cut loin portion can be cut into center cut chops, roast sections, or boned out into a boneless loin. See below for directions for fabricating a boneless loin.

1. Remove the tenderloin from the underside of the backbone.

2. Separate the ribs and backbone from the loin muscle. Separate the ribs from the backbone to make back ribs.

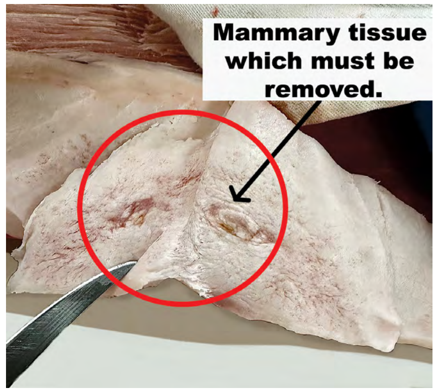


3. Remove secondary muscles and external fat if desired. The loin can be left whole or fabricated into boneless center cut chops.

Belly

1. Remove the skin (if applicable).

2. Remove any remaining mammary tissue from the belly and discard it.



3. Remove the spareribs from the belly. Start on the anterior portion of the belly and cut along the underside of the ribs. At the end of the ribs, find the pocket of cartilage that curves along the rib bones towards the sternum and follow it until the ribs are completely removed. Remove any leaf fat and the sternum.

4. Square up the posterior end of the belly, removing any lymph nodes visible in the fat.

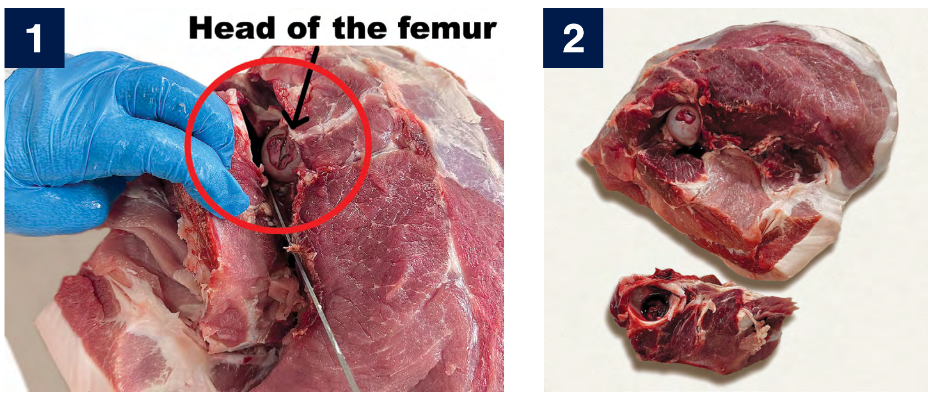
5. Remove any remaining leaf fat on the belly.

Ham

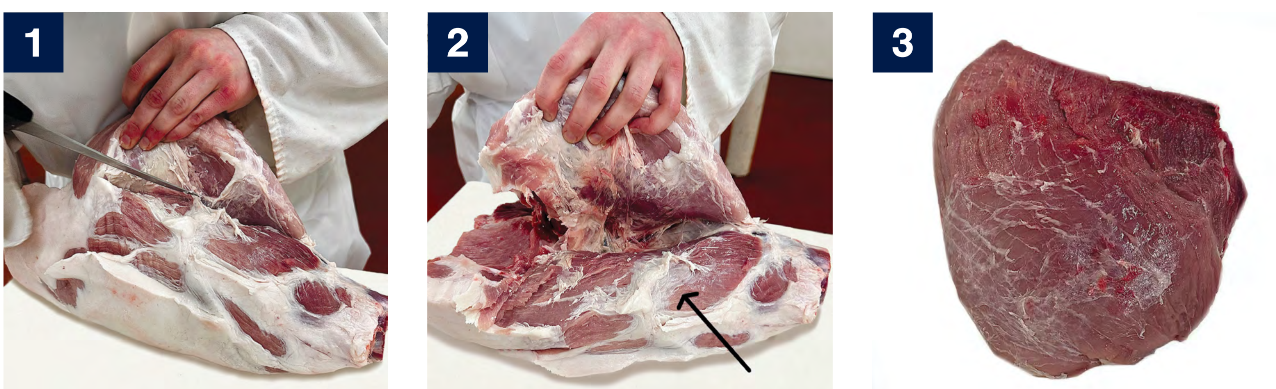
1. Skin the ham (if applicable).

2. Remove the aitch bone by cutting around the bone, including the open face of the ham. Locate the ball and socket joint connecting the femur to the aitch bone.

3. Sever the ligament holding the head of the femur in place within the socket of the aitch bone. Remove the aitch bone from the ham.



4. Identify the seam between the inside ham and the ham eye located on the side of the ham. If seams are not visible, trim away the external fat. Remove the inside ham and trim the fat from the cut.



5. Identify the ham eye, a long cylindrical shaped muscle resting on the outside ham and follow the seam to remove it. This cut can be left as a roast or placed into trim.

6. Identify the knuckle, located on the opposite side of the ham from the ham eye. Remove the knuckle by cutting under the femur and following the heavy fat seam surrounding the muscle. Trim the cut of fat and heavy connective tissue. This cut can be left as a tip roast or used for further processing.

7. Remove the femur bone and the remainder of the bones in the ham.

8. Remove the heel muscle from where the bone structure was removed.

9. The remaining cut is the outside ham. Remove any remaining connective tissue, fat, or dried meat on the outside of the muscle.

Pork Carcass Yield

Similar to beef, consumers may be concerned about final yield compared to the live weight or even the carcass weight of a pig. The average dressing percentage of a pig is between 70 and 75%. Dressing percentage is more variable for pigs because carcasses can be left skin on or head on or one or both can be removed prior to chilling. Pork carcasses also experience shrink, or weight loss, during chilling of 2-5%. The final yield will range from 65% (for boneless retail cuts) to 74% (for bone-in cuts) of the cold carcass weight.

Example

- **Live weight:** 250 lbs.
- **Dressing percentage:** 73%
- **Shrink:** 3%
- **Boneless retail cuts:** 65%
- **Retail yield:** 250 lbs x 73% = 182.5 lbs x 97% = 177 lbs x 65% = 115 lbs.

Approximate Percentages of Cuts from a Pork Carcass*

Primal (bone-in)	Approximate Yield (% of carcass weight)
Boston Butt	10%
Picnic Shoulder	11%
Loin	25%
Belly	21%
Ham	25%
*These are approximate numbers for primal weight percentages including all bone and fat, although carcasses can vary. This chart is adapted from UW Madison Extension, *How much meat should a hog yield?*	

Common Names of Pork Cuts

Much like with beef, cuts from a pork carcass can have many different names based on geographic location. Below is a compiled table of various names for different pork cuts in the United States.

Cuts from the Boston Butt	Alternative Names
Blade Boston Butt Roast Bone-In	Pork Shoulder Blade Roast, Pork Butt Roast, Boston Shoulder, Blade Roast, Pork Shoulder, Pork Butt, Collar Butt, Pork Collar, Shoulder Blade Roast, Boston-Style Butt
Blade Boston Roast Boneless	Boneless Boston Butt, Boneless Pork Shoulder Roast, Rolled Butt Roast, Butt Roast, Boston Roast, Shoulder Roll
Shoulder Chop	Boston Butt Steak, Blade Chop, Blade-End Chop, Pork Shoulder Steak, Shoulder Blade Chop, Shoulder Steak, Blade Steak, Pork Loin Blade Chops, Pork Steak, Pork Blade Steak
Country Style Ribs	Blade-End Ribs, Shoulder Ribs, Country Ribs, Country Style Pork Ribs

Cuts from the Picnic Shoulder	Alternative Names
Picnic Shoulder Bone-In or Boneless	Pork Shoulder, Picnic Roast, Picnic, Picnic Ham, Arm Shoulder, Arm Picnic

Cuts from the Loin	Alternative Names
Bone-In Blade Roast	Blade-End Pork Loin Roast, Pork Blade Roast, Blade Loin Roast, Pork Loin Rib Half, Rib Roast, Rib End Pork Loin
Boneless Blade Roast	Chefs Prime Roast, Chefs Prime, Blade Loin Roast, Loin Rib Half, Rib Roast, Rib End Pork Loin
Pork Loin Country Style Ribs	Blade-End Ribs, Shoulder Ribs, Country Ribs, Country Style Pork Ribs
Back Ribs	Baby Back Ribs, Pork Back Ribs, Loin Back Ribs, Canadian Back Ribs
Pork Rib Roast	Rack of Pork, Pork Roast, Pork Center Loin Roasts
Pork Crown Roast	Crown Roast, Frenched Pork Crown Roast
Top Loin Roast Bone-In or Boneless	Pork Loin Roast, Center-Cut Pork Loin Roast, Center-Cut Pork Roast, Pork Loin
Top Loin Double Roast Bone-In or Boneless	Double Pork Loin Roast, Boneless Pork Roast
Tenderloin	Pork Tender, Pork Filet, Filet of Pork
Sirloin Roast	Sirloin End Roast, Pork Hipbone Roast, Pork Loin End Roast
Pork Loin End-Cut Chop	Loin Chop, Loin Pork Chop, End-Cut Chop
Pork Loin Center-Cut Chop	Loin Chop, Center Loin Chop, Center-Cut Loin Chop, Porterhouse Chop, Top Loin Chop, Loin Pork Chop
Pork Loin Rib Chop	Pork Rib Cut Chop, Rib Chop, Pork Chop End-Cut, Rib Pork Chop, Center-Cut Rib Chop, Rib End-Cut, Frenched Rib Chop, Blade Chop, Ribeye Chop
Pork Sirloin Chop	Sirloin Steak, Tenderloin Chop
Boneless Chop	America's Cut, Pork Loin Filet, New York Chop, Boneless Center-Cut Chop

Cuts from the Belly	Alternative Names
Pork Belly	Side Pork, Belly
Spareribs	Side Ribs, St Louis Style Ribs, South Side Ribs, Spares, Pork Ribs
St. Louis Style Ribs	St Louis Cut Ribs, St Louis Ribs

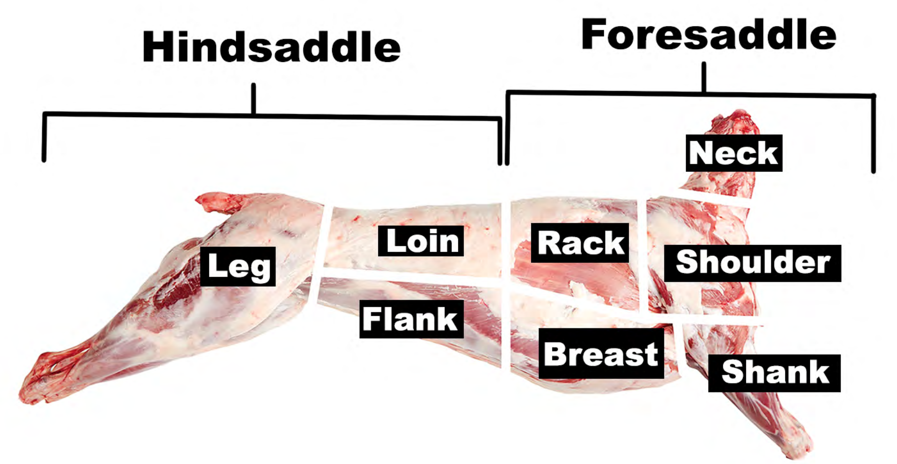
Cuts from the Ham	Alternative Names
Pork Leg Whole Bone-In	Fresh Pork Leg Bone-In, Fresh Ham Bone-In
Pork Leg Whole Semi-Boneless	Fresh Pork Leg Semi-Boneless, Fresh Ham Semi-Boneless
Pork Steamship Roast	Pork Steamship Leg, Handle-On Semi-Boneless Leg
Pork Leg Whole Boneless	Fresh Pork Leg Boneless, Fresh Ham Boneless
Pork Leg Shank Roast Bone-In	Fresh Ham Shank End, Leg Roast Shank Half, Pork Leg Roast, Pork Leg ¼ Shank, Fresh Ham Shank End, Fresh Ham Shank Roast, Fresh Ham Shank Half
Fresh Ham Butt End Boneless	Pork Leg Sirloin Half, Fresh Ham Sirloin Half, Pork Butt Roast (Leg), Fresh Ham Rump Half, Butt Half Fresh Ham, Pork Leg Sirloin Half, Pork Leg Butt, Fresh Ham Butt
Inside Ham Boneless	Fresh Ham Top Roast, Pork Leg Top Roast, Pork Inside Roast, Pork Top Round Roast, Pork Top Ham
Outside Ham Boneless	Fresh Ham Bottom Roast, Pork Outside Roast, Pork Bottom Round, Pork Bottom Ham
Pork Tip Roast Boneless	Fresh Ham Tip Roast, Fresh Ham Sirloin Tip Roast, Pork Knuckle Roast, Pork Leg Tip Roast
Ham Center Slice	Ham Steak, Fresh Ham Steak
Ham Hock	Pork Knuckle, Pork Hock, Pork Shank
Pork Feet	Pig Feet, Trotters

Lamb

Within this section lamb primals, lamb fabrication, and yield differences will be covered. Also included is a chart with different names of common lamb cuts.

Lamb Primals

Lamb can be broken down into 8 different primals. These primals are divided into the foresaddle or hindsaddle of the carcass. Primals from the foresaddle of the carcass include the rack, breast, neck, shoulder, and shank. Primals from the hindsaddle include the loin, the flank and the leg. The image below shows where each of these primals are located.



Lamb Fabrication

Lamb fabrication is unique compared to beef and pork as carcasses are not split in half before the chilling process. The desired cuts impact the fabrication of the carcass. The first step when fabricating a lamb carcass is to separate the foresaddle from the hindsaddle. Much like beef, the foresaddle and hindsaddle are separated by making a cut between the 12th and 13th ribs.

Foresaddle Primal Fabrication

1. Remove the neck where the neck meets the top of the shoulder.

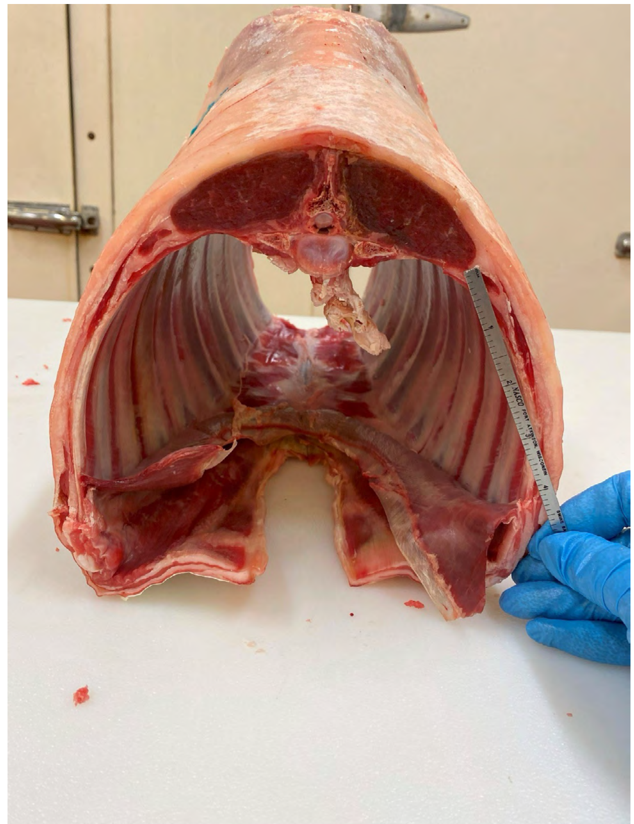
2. Split the shoulder from rack primal between the 4th and 5th ribs, counting from the anterior of the carcass.

3. Split the section with the shoulder, breast, and shanks in half down the backbone.

4. Separate the shank and breast from the square cut shoulder parallel to the backbone through the cartilage where the first rib meets the sternum bone.

5. Remove the breast from the shank along the natural seam.

6. Make a straight cut 4 inches from the outer tip of the ribeye muscle on the rack to separate the breast and rack.



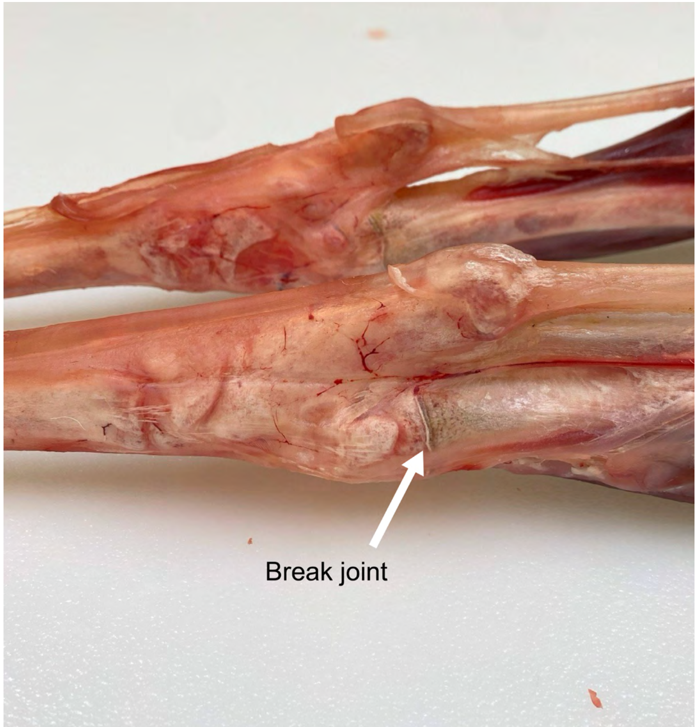
Hindsaddle Primal Fabrication

1. Separate the loin and flank from the leg anterior to the hip bone. To find the hip bone, locate the indent at the posterior end of the loin, where the loin meets the sirloin and the backbone curves up. You should be able to stick a knife all the way through the carcass, near the backbone if you have found the right location. If you are too far posterior, you will hit hip bone with your knife.

2. Separate the flank from the loin approximately 1 inch from the loineye muscle on all sides of the loin. A saw will be needed to cut through the remaining ribs on the loin.



3. Use a saw to remove the lower leg bone at the break joint (pictured below) and split the legs down the backbone.



Individual Primal Fabrication

Neck

The neck is often put into trim. However, it can be saved whole as a bone-in roast, sliced into neck chops, or boned out into a boneless neck roast.

Shoulder

The square cut shoulder can be left whole, cut into 1” cubes for stew meat, or cut into arm or blade chops

Bone-In Shoulder Fabrication

1. Arm chops can be taken from the ventral side of the square cut shoulder where the shank was removed, and blade chops can be taken from the posterior side where the rack was removed. Each square cut will yield 3-4, 1” thick arm chops and approximately 3, 1” thick blade chops.
2. The remainder of the shoulder can then be left whole, boned out for trim, or cubed into stew meat.

Breast

Denver Style ribs are the only major cut from the breast.

1. Separate the ribs from the sternum at the cartilage juncture. The rest of the breast can be used for trim.

Shank

The shank is often left whole or used for trim.

Rack

1. Separate the rack into two halves by sawing down the backbone

2. Remove the cap muscles and trim the fat to ¼" or less. The rack can be left whole, frenched, or fabricated into rib chops.

Frenched Rack Fabrication

1. Remove the chine from each side of the rack. The chine is the part of the vertebrae that holds the spinal cord. When done correctly, removal of the chine will allow for cutting rib chops apart with a knife.
2. Starting at the ventral edge of the ribeye muscle, remove the muscle and fat from each rib bone, including the tissue between the ribs. The frenched rack can be left whole or fabricated into frenched rib chops.

Loin

Bone-In Loin Fabrication

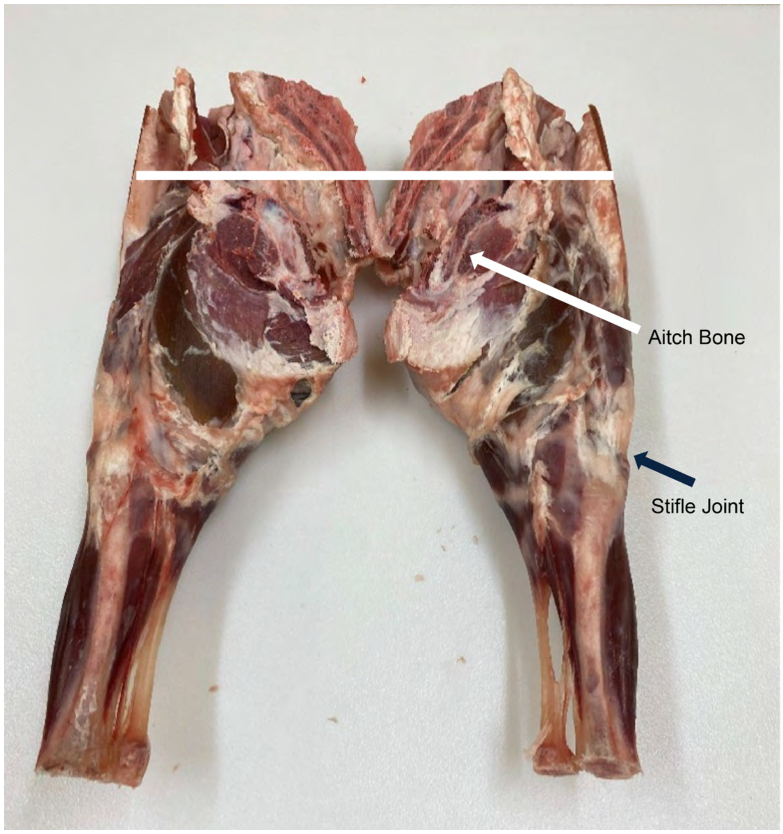
1. Trim external fat on the loin to less than ¼".
2. Remove the kidney fat, diaphragm, and hanging tender located on the internal side of the loin, attached to the backbone. The loin can be left whole or cut into double or single loin chops.

Flank

The flank is generally processed into trim.

Leg/Sirloin

The sirloin can be left attached to the leg or separated 1” anterior to the aitch bone for bone-in or boneless sirloin chops or roasts.



Bone-In Leg Fabrication

Remove the trotter, the bony lower leg, at the stifle (knee) joint. Bone-in legs can be left whole or fabricated into roasts of the desired size.

Boneless Leg Fabrication

1. Locate the aitch bone and remove it, severing the ligament connecting the ball and socket hip joint as described in the beef and pork sections.
2. Cut along the femur and remove it from the rest of the leg.
3. Remove the fat from the area the femur was removed. The boneless leg can be placed in netting before packaging for retail to aid in more even cookery.

Lamb Carcass Yield

Lamb carcasses have significantly less total yield compared to beef and pork. The average dressing percentage of lamb is between 44 and 56%. If the lamb is shorn, meaning the wool has been trimmed short, dressing percentage will be higher than if the lamb is unshorn. Carcasses can also lose 2-5% of their weight during chilling known as shrink. The carcass yield will range from 43-50% (for boneless retail cuts) to 65-75% (for bone-in cuts) of the hot carcass weight.

Example

- **Live weight:** 150 lbs
- **Dressing percentage:** 50%
- **Shrink:** 3%
- **Boneless yield:** 45%
- **Retail yield:** 150 lbs. x 50% = 75 lbs. x .97% = 72.75 lbs. x 45% = 32.75 lbs.

Approximate Percentages of Cuts from a Lamb*

Primal (bone-in)	Approximate Yield (% of carcass weight)
Shoulder	23%
Rack	15%
Loin	12%
Leg	33%
Foreshank and Breast	12%

*These are approximate numbers for primal weight percentages including all bone and fat, carcasses can vary. Chart is adapted from UW Madison Extension, *How much meat should a lamb yield?*

Lamb Cut Names

It is not uncommon for names of different cuts to vary based on geographic location. Here is a compiled table of various names for different lamb cuts in the United States.

Cuts from the Neck	Alternative Names
Neck Rosette	Bone-In Neck Roast
Neck Chop	Lamb Neck Chop, Neck Slice, Cross-Cut Neck
Neck Filet Roast	Boneless Neck Roast, Boneless Neck

Cuts from the Shoulder	Alternative Names
Lamb Arm Roast (Bone-In or Boneless)	Lamb Shoulder Roast, Lamb Shoulder, Oyster Roast, Arm Clod
Lamb Shoulder Chop (Bone-In or Boneless)	Lamb Arm Chop, Lamb Shoulder Chop
Lamb Blade Chop (Bone-In or Boneless)	Lamb Blade Chop, Lamb Shoulder Chop
Lamb Blade Roast (Bone-In or Boneless)	Lamb Shoulder Blade Roast, Arm Clod, Boneless Shoulder Roast
Boned and Rolled Shoulder	Boneless Rolled Shoulder, Rolled Shoulder, Lamb Shoulder Roll, Shoulder Roll Roast
Square Cut Shoulder	Square Cut Lamb Chuck
Saratoga Roll	Lamb Shoulder Eye Roast, Lamb Chuck Eye
Forequarter Rack	Lamb Rack
Shoulder Ribs	Lamb Shoulder Ribs, Ribs

Cuts from the Shank	Alternative Names
Lamb Shank	Lamb Whole Shank

Cuts from the Breast	Alternative Names
Whole Lamb Breast	Lamb Breast with Bone, Bone-In Lamb Breast
Lamb Breast Roll	Boneless Rolled Lamb Breast, Rolled Breast (Bone-In or Boneless)
Lamb Ribs	Lamb Riblets, Lamb Spareribs, Denver Style Ribs, Denver Ribs

Cuts from the Rack	Alternative Names
Rack	Lamb Frenched Rack, Lamb Rack Whole
Crown Roast	Rib Crown Roast, Lamb Crown Roast
Rib Chop	Lamb Rack Chop, Lamb Rack Cutlet, Lamb Chop, Lamb Popsicle, Lollipop
Rib Roast Bone-In	Bone-In Lamb Rack
Rib Roast Boneless	Boneless Lamb Rack
Ribeye Roll	Lamb Rack Boneless Roast
Lamb Spareribs	Denver Ribs, Spareribs, Lamb Riblets

Cuts from the Loin	Alternative Names
Lamb Loin Chop	T-Bone Lamb Chop, Lamb T-Bone, Loin Chop, Porterhouse Chop
Lamb Double Loin Chop	Double Loin Chop, Barnsley Chop, Saddle Chop, Saddle Loin Chop
Loin Roast (Bone-In or Boneless)	Eye of Loin, Boned and Rolled Loin, Loin Roast, Loin Eye Roast

Cuts from the Loin	Alternative Names
Tenderloin	Lamb Filet, Lamb Loin Filet, Lamb Filet Mignon
Medallions	Noisettes, Boneless Loin Medallions

Cuts from the Flank	Alternative Names
Lamb Flank	Lamb Rolled Flank (Boneless), Lamb Flank Steak

Cuts from the Leg	Alternative Names
Leg of Lamb Bone-In	Whole Lamb Leg, Bone-In Lamb Leg
Leg of Lamb Semi-Boneless	Semi-Boneless Lamb Leg, American Style Leg Roast
Leg of Lamb Boneless	Boneless Leg (Whole), Boneless Leg Roast, Boneless Rolled Lamb Leg
Frenched Leg	Frenched Leg of Lamb, French Cut Leg, Lamb Leg Steamship Roast
Sirloin Roast	Sirloin Tip Roast, Lamb Sirloin, Lamb Rump Roast, Knuckle
Sirloin Steak	Sirloin Rump Steak, Sirloin Chump Chop, Sirloin Chop
Center Leg Roast	Lamb Leg Roast (Bone-In or Boneless)
Inside Round	Top Round Roast, Boneless Lamb Leg Roast
Outside Round	Bottom Round Roast, Boneless Lamb Leg Roast
Leg Chop	Lamb Leg Chops, Lamb Center Cut Chops
Leg Steak (Bone-In)	Leg Steak Center Slice, Lamb Leg Center Slice
Lamb Leg Cutlet	Lamb Leg Steak, Boneless Leg Steak
Shank Roast	Shank End Roast, Lamb Shank Roast, Lamb Hind Shank
Lamb Tenderloin	Lamb Filet, Lamb Loin Filet, Lamb Filet Mignon

Factors That Influence Carcass Yield

There are many factors that impact yield across all species including: carcass chilling, animal breed, fat content, bone, method of cutting (boneless versus bone-in cuts), carcass aging (wet versus dry age), and carcass defects.

Carcass Chilling

The carcass chilling process results in cooler shrink (or a decrease in carcass weight) mainly through evaporation of water. Muscle is comprised of approximately 70-75% water. Carcasses can lose 2-5% within the first 24 hours of chilling. The longer carcasses chill, the more loss there will be. Cooler humidity and wind speed drastically impact cooler shrink. Lower humidity and higher wind speeds contribute to more evaporation and more shrink. However, air movement needs to be adequate to remove heat from the carcasses.

Animal Breed

The breed of an animal can impact yield due to differences of both genetics and physical carcass characteristics. Particularly in cattle, beef type breeds, such as Limousine and Charolais, tend to be heavier muscled than animals used for dairy purposes, resulting in greater meat yields. Dairy animals tend to be leaner and taller (which results in increased bone weight), with larger heads compared to beef animals. Much like the cattle example, pork and lamb can have varying carcass compositions depending on breed. For example, 100% purebred duroc pigs have been found to have increased meat yields compared to cross-bred durocs (Santos et al., 2023). Additionally, studies have shown lamb breeds also yield differently. Meat type breeds (Hampshire and Dorset Down) were found to yield more than the wool producing breeds (English Leicester and Merino; Kirton et al., 1996). In the same study there were also variation in primal weights between breeds, resulting in variation in primal yields based on breed.

Fat Content

Over finished animals with excess internal and external fat generally require more trimming to make retail cuts. Retail cuts are usually trimmed to ⅛ to ¼ inches of external fat. If an animal is overly fat, it could yield a lower percentage of meat than leaner animals. For example, an 850 pound steer carcass with 1.5" of backfat will yield a lower percentage in total cuts compared to an 850 pound steer carcass with ¾" of backfat fabricated to the same specifications. The more trimming that is required, the more the hot carcass weight is removed, resulting in a lower yield.

The amount of fat desired in ground product will also impact take home yield. If a customer desires a 90% lean ground product, there will be less product generated compared to product with lower lean percentages such as 80% lean. This is because less fat is saved and used for making the ground product.

Bone Weight

Frame size impacts overall yield. Larger framed animals with longer legs or larger heads will have a lower yield if fabricating boneless cuts. This is especially true for dairy cattle breeds that are generally lighter muscled than beef cattle breeds.

Method of Cutting

Method of cutting is determined by processor or consumer preference. A consumer's request for more external fat left on cuts or boneless instead of bone-in product will impact yield. Choosing boneless cuts will always decrease overall yield because the weight of the bone is removed from the product. Additionally, in many cuts, if heavy connective tissue is not removed, it will result in a less desirable eating experience. For this reason, heavy connective tissue depots removed for quality purposes will reduce yield. A good example of this is the flat iron steak. The flat iron has a heavy connective tissue layer in the middle of the cut. If it is left in, there will be an inedible portion of the steak that will reduce consumer satisfaction. If it is removed, the steak will likely produce a satisfactory eating experience as it is the 2nd most tender steak in the carcass.

Carcass Aging

While aging is done to enhance overall product tenderness and flavor, increased aging times can reduce product yield. Dry aged products have decreased yield compared to wet aged because of increased water loss and more trim loss of the dehydrated product. In comparison, wet aging does not substantially impact product yield because product is not subjected to dehydration. Dry aging a whole carcass for 14 days can reduce the carcass weight by 5-7%. For more information on this see the Aging section.

Carcass Damage

Carcass damage reduces yield because it is removed prior to sale of product. Damage can be anything the inspector deems unfit for consumption, including bruising, injection site lesions, and abscesses. Carcass bruising occurs prior to slaughter. This often happens when the animal is transported to the facility, during loading and unloading through chutes and trailers, or when co-mingling animals from different pens, especially horned animals. Some of the most common areas for bruising on a beef carcass include along the topline and in the rib and hip areas. Bruised tissue must be removed from the carcass resulting in an economic loss as well as an animal welfare issue. Calm handling is an important concept that all processing facility employees should be familiar with and trained in.

Injection site lesions are pockets of infection on the carcass and are always removed when found. Additionally, injection site lesions indicate a risk of drug residue within the carcass, requiring additional testing which, if positive, can result in carcass condemnation. Similar to injection site lesions, abscesses are pockets of infection that pose a food safety risk if consumed. Abscesses can be caused by many things including diet (noted in livers of cattle) or resulting from an injury such as blunt force trauma, or a puncture or scrape. When a lesion or abscess if found in a carcass, care should be taken when removing it. Sanitize knives and saws that come in contact with the infected tissue, and clean cutting surfaces in the instance of contamination. Although it decreases overall carcass yield, removal of carcass damage is critical to keep the products safe for consumption.

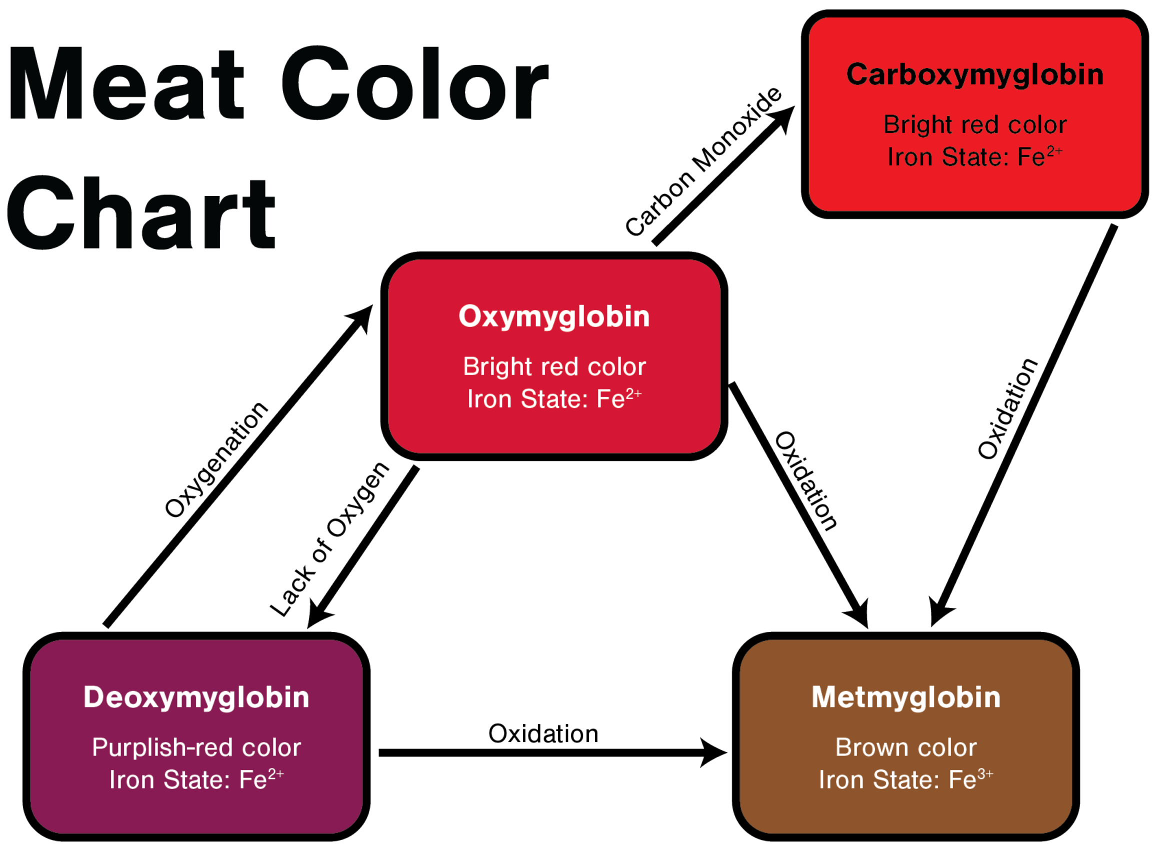
Common Consumer Questions and Concerns

Color

Consumers have expectations for the appearance of meat and they often associate appearance attributes with wholesomeness of products. Factors such as color, marbling content, and fat thickness are a few different examples of visual properties that influence consumers' opinions of the value and freshness of a product and ultimate purchasing decisions. Color is the primary trait consumers will associate with product freshness, and color expectations vary among species. Consumers expect beef to be bright cherry red, pork to be reddish-pink, and lamb to be pinkish-red.

Meat color is determined by a protein within muscle called myoglobin. Increased myoglobin concentration results in a darker red colored meat product. There are many factors that can influence myoglobin and impact the color of meat. Animal handling, product handling, packaging, and the environment play large roles in meat color development. Oxygenation, or the exposure of meat to oxygen, can be both favorable and unfavorable for color development. Oxygen presence will cause meat to bloom into the desirable colors mentioned earlier. On the other hand, oxidation occurs when meat has prolonged exposure to oxygen, light, or heat. Oxidation of myoglobin results in a color change to brown that will be further discuss later in this section. Additionally, oxidation of fats within meat can contribute to rancidity, resulting in off odors and flavors within product.

It is not uncommon to see discoloration of meat products. While a brown or dark purplish-red colored steak isn't as visually appealing as a bright cherry red steak, unless fat rancidity has occurred, there is often no difference in product odor or flavor. The cause of undesirable meat colors can be explained by the chemical reactions caused by the environment meat is exposed to. The diagram explains some of the reactions occurring.



Meat Color Chart, adapted from Principles of Meat Science, fourth Edition.

Red Meat

The most commonly formed red colored pigment in meat is known as oxymyoglobin and it is formed when oxygen binds to myoglobin. Consumers associate this color with freshness, but it is not inherently stable. Eventually, oxidation will turn the meat brown. The following pictures show the oxidation of ground beef in a mock retail setting for eight days. The ground beef was packaged in retail overwrap and subjected to light 24 hours per day. The picture on the left is on the first day of the simulation and the right picture is the same product on day eight.

Carboxymyoglobin is another pigment that can be responsible for the red color. This occurs when meat is exposed to a food grade gas mixture containing a small amount (~0.4%) of carbon monoxide in modified atmosphere packaging. It is significantly more stable than oxymyoglobin because it is more resistant than oxygen to the effects of oxidation. This aids in color preservation, extending retail case life from a color stability perspective. Carboxymyoglobin is commonly achieved in Modified Atmosphere Packaging (MAP), which is discussed later.

Dark Purplish-Red Meat

Meat changes to a darker color when oxygen is removed from its environment, such as with vacuum sealed products. As oxygen is eliminated from the environment, oxymyoglobin undergoes a chemical reaction changing to deoxymyoglobin, which is often described as a dark purplish-red color. This change in color does not impact the flavor of meat, but some consumers might find the appearance less desirable. However, this is a reversible color change. Once a product is exposed to oxygen again, the color will return to the oxymyoglobin pigment. Dark colored beef can also be the result of a condition called dark, firm, and dry, also known as a dark cutter, which will be discussed in the Trouble Shooting sections.

Brown Meat

Exposure of meat to oxygen and light causes oxidation resulting in the formation of a brown colored pigment in the product known as metmyoglobin. The higher the concentration of metmyoglobin in meat, the more the product will discolor. During the oxidation process, oxygen, light, and/or heat chemically alter the iron state of myoglobin. This change to a brown color does not necessarily indicate the meat is spoiled or unsafe to eat. Oxidation alone does not equate to a food safety issue, but it does contribute to a shorter retail case life of product. However, many consumers associate browning in raw meat with a safety issue, and are less likely to purchase discolored product, especially if more visually appealing options are available. Discoloration of beef products is a large contributor to food waste from the meat counter. One study estimated that 2.55% of retail beef is discarded as a result of discoloration, valuing $3.73 billion annually and equaling approximately 780,000 animals (Ramanathan et al., 2022). To help prevent metmyoglobin formation, different forms of packaging that delay oxidation can be used to reduce oxygen or light exposure.

Overall, it is important to keep in mind that meat color is an indicator of quality, not food safety, and purchasing decisions ultimately come down to consumer preferences and willingness to pay.

Meat Storage

The way meat products are packaged and stored will affect the recommended case-life. In this section the recommended times for storage of fresh and frozen meat products are discussed.

Frozen Storage

Freezing is an excellent option for long-term meat storage. Freezing temperatures slow microbial and enzyme activity to a minimum, enabling frozen products to stay wholesome longer. As long as the product stays frozen, microbial activity slows substantially until the meat is thawed, although quality of product can deteriorate after a certain period due to freezer burn. Freezer burn occurs when moisture is lost from meat, causing discoloration, odors, and off flavors that diminish the eating experience. Certain forms of packaging are better at preventing freezer burn than others. Packaging that exposes meat products to oxygen tends to diminish in quality faster in the freezer than packaging that eliminates oxygen (such as vacuum packaging). This is because the more air or oxygen exposure meat has, the faster it will lose water and dry out in the freezer. Optimum storage times for best quality at 0°F can be found in the table below.

Frozen storage case-life.

Product Type	Frozen Storage Shelf Life (0°F)
Bacon and Sausage	1-2 Months
Ham/Hot Dogs/Lunch Meats	1-2 Months
Raw Whole Muscle Cuts: Roasts, Steaks, Chops	4-12 Months
Raw Ground Product	3-4 Months
Cooked Meat	2-3 Months
Raw Poultry Whole Bird	12 Months
Raw Poultry Parts	9 Months
Cooked Poultry	4 Months
Raw Wild Game	8-12 Months
Table adapted from USDA FSIS	

Fresh Storage

Fresh meat case life will vary depending on the product and packaging type. The more microbial growth and oxidation are slowed, the longer the retail case life will be. While refrigerated temperatures do slow microbial activity and enzymes responsible for muscle structural degradation, it does not slow it to the same extent as frozen temperatures. For this reason, fresh meat has a shorter retail case life than frozen meat. A storage time table for fresh meats below 40°F can be found below.

Storage time for fresh meats.

Product Type	Fresh Storage Shelf Life (Below 40°F) for Aerobic Packaging
Bacon	1 Week
Hot Dogs (opened vs. unopened)	1-2 Weeks
Lunch Meat (opened vs. unopened)	3-5 Days or 2 Weeks
Raw Whole Muscle Cuts: Roasts, Steaks, Chops	3-5 Days
Raw Ground Product	1-2 Days
Cooked Meat	1 Week
Table adapted from foodsafety.gov.	

Packaging

Packaging has a variety of different functions that influence purchasing decisions. Product appearance is important in the food industry because it is a primary influencer of consumer purchasing decisions. Consider the appearance of most candy. Often candy and its packaging are bright and colorful. This is an intentional marketing tactic, as most candy is targeted at children, who are attracted to fun, bright colors. Consumers of meat products are no different and are heavily invested in product appearance. If consumers deem that a product is unattractive, they will likely purchase something else. Consumers associate meat color with freshness and wholesomeness, any deviations from the preferred expected colors of meat results in decreased sales (Ramanthan et al., 2022). In fact, one study found that the average willingness to pay for beef dropped by $2.00 per pound when ground beef was brown rather than a cherry red color (Grebitus et al., 2013). Packaging can help mitigate discoloration of products through extension of shelf life. The type of product being sold and whether it is fresh or frozen will influence which forms of packaging are optimal for the appearance of the product.

Packaging serves to protect products from contamination while maintaining quality during transport, storage, and retail. There are three main categories of packaging utilized for meat products within the industry: aerobic, anaerobic, modified atmosphere and roll stock. Numerous packaging types fall within each of these categories, each with their own benefits and disadvantages.

Types of Packaging

Aerobic

Aerobic packaging allows the presence of oxygen and is considered air permeable. Therefore, products in this form of packaging are exposed to oxygen. Oxygen exposure in a fresh retail case setting is beneficial, as oxygenation helps contribute to the ideal bloomed meat color. However, after a period of time, oxidation will occur resulting in browning and oxidative rancidity, which will result in off odors or flavors. Since aerobic packaging is air permeable and allows for more rapid oxidation, it has the shortest retail case life. However, case life will still be variable among types of aerobic packaging. Two common types of aerobic packaging include butcher paper and PVC tray overwrap. Aerobic packaging works great in a fresh retail case setting involving short-term storage, and it is relatively inexpensive.

Butcher Paper

Butcher paper is an inexpensive, classic form of packaging. It works well for both fresh and frozen products, as long as the product is wrapped tightly. Air pockets under the wrapping enables oxygen to access the product, which contributes to shorter shelf life and faster rates of freezer burn and rancidity. Ensuring a proper seal not only minimizes food safety and quality risks, but it also makes the package more appealing to the consumer. While butcher paper is an excellent option for packaging, there are a few disadvantages from a consumer standpoint. Lack of transparency with this type of packaging can be less desirable for consumers who like to see the products they are purchasing. Additionally, it takes well practiced employees to consistently wrap products well and get a tight wrap, reducing oxidation and freezer burn. Finally, butcher paper only has a fresh retail case life to 3-5 days before off flavors, odors, and colors in meat can be seen. For whole muscle frozen product wrapped in butcher paper with a proper seal, the case life is 4-6 months before quality issues are detected.

PVC Tray Overwrap

Tray overwrap can be a good option for packaging fresh meat in a retail case setting when product is sold quickly. Not only is the packaging transparent, allowing the consumer to see the product, but it is also air-permeable aiding in meat color development desired by consumers. For example, a tray overwrapped ribeye steak is going to experience oxygenation, blooming to a bright cherry red color. While oxygen is great for products in this type of packaging for a short period of time, exposure to oxygen results in oxidation and product discoloration. Tray overwrap packaging does not do well with freezing as freezer burn and rancidity occur more quickly with oxygen exposure. Additionally, this form of packaging can be more tedious, requiring extra care to get the proper seal. Tray overwrapped products have the shortest fresh retail case life of 3-4 days before off odors, flavors, and discoloration are identifiable (Cenci-Goga et al., 2020).

Anaerobic

Anaerobic packaging reduces oxygen presence, with 75-90% of air being removed from the package. Since this form of packaging is not air permeable, it creates an uninhabitable environment for aerobic bacteria, and it has a longer retail case life. Although most of the oxygen is removed from the packaging, it does not necessarily reduce effects of oxidation since the product may still be exposed to light or heat. Additionally, removal of oxygen shifts the color of fresh meat to a dark purplish-red, which consumers can find unappealing. Anaerobic packaging can be used on both fresh and frozen products and works well for long term storage of product especially for further processed and cooked meats. An example of anaerobic packaging is vacuum packaging.

Vacuum Packaging

Vacuum packaging can be transparent, which helps the consumer see the products they are purchasing, with the addition of enhanced microbial control since it removes most of the air from the package once sealed. However, vacuum packaging will result in dark purplish-red colored meat due to lack of oxygen presence which is considered less desirable than bright red according to consumers. Since oxygen in the product's environment is greatly reduced with this packaging type, the retail case life is longer than aerobic packaging types. The USDA recommends fresh vacuum sealed whole muscle products to be used within 7 days of purchase before quality deterioration. Additionally, if no damage has occurred to the packaging, vacuum sealed frozen meat products can last significantly longer than aerobic options. However, if the seal is broken due to puncture or rough handling, freezer burn can still occur. The machinery and bags for this packaging system are more expensive than the previously discussed aerobic packaging methods. However, vacuum sealing can save some time and labor, requiring less training for an employee to learn how to package. Additionally, this form of packaging can be difficult to use with bone-in products. Unless bone guard materials are used, it is easy for the sharp edges to puncture bags and cause the loss of vacuum environment.

Modified Atmosphere Packaging (MAP)

Modified atmosphere packaging (MAP) is a packaging system that is flushed with a food grade gas mixture. The gaseous mixture can contain one or a variety of gases including oxygen, carbon dioxide, carbon monoxide, and nitrogen. Nitrogen makes up the largest percentage in this gas mix and is typically added to prevent package collapse and to replace oxygen presence. Carbon dioxide is added to inhibit bacteria growth. Finally, carbon monoxide stabilizes meat color for longer periods of time altering the pigment of meat to carboxymyoglobin. This reduction in microbial growth and improved color stability contributes to MAP packaging having a longer fresh retail case life than aerobic packaging. Overall, MAP packaging is excellent for long term storage in a retail display, with better resistance to rancidity and minimal impacts of oxidation because it can aid in color stabilization.

Aging

Aging meat is a technique utilized to increase tenderness and enhance flavor development within fresh meat. Tenderness formation occurs when enzymes naturally occurring in meat break down muscle structure. These enzymes are drastically slowed at freezing temperatures, so aging must be done prior to freezing. Aging can be done using dry or wet methods and is typically only done with beef in the U.S. This is because there is less need for tenderization of both pork and lamb as pork and lamb are generally harvested at a younger age than beef. Both methods of aging are proven to result in more tender products desired by consumers.

Dry Aging

Dry aging involves hanging a carcass or shelving whole primals for an extended period under controlled temperature, air speed, and humidity prior to fabrication. Longer dry aging periods may result in increased tenderness and flavor development, but they also correspond with increased yield loss due to product dehydration. While different processors utilize a variety of cooler settings to dry age, the ideal temperature is 32 to 39.2° F, with a humidity of 61 to 85%, and an air flow speed of 1.5 to 6.75 feet per second in the cooler (Dashdorj et al., 2016). It is important to note that increased temperatures and humidity will promote more rapid bacterial growth, which could contribute to faster development of off odors and flavors within the product. Additionally, humidity that is too low can contribute to greater product weight loss caused by increased dehydration. Optimal airflow is also key to dry aging products. Without sufficient airflow, the dry aging process is less efficient, but too much air flow will cause excessive dehydration. One way to mitigate yield loss is by leaving all fat and bone on the product when aging to reduce the surface area of meat exposed to air.

Dry aging beef contributes to an enhanced unique nutty/beefy flavored product, which consumers have been able to identify (Sitz et al., 2006). Consumers who particularly enjoy the flavor of dry aged beef are usually willing to pay more for it, increasing its value and offsetting the cost of product loss.

Wet Aging

Wet aging involves storing beef products in a sealed vacuum package at refrigerated temperatures. Typically, wet aging is done with high value subprimals commonly used for steaks, such as strip loins or ribeye rolls. Wet aging has a better final yield compared to dry aging because there is no surface dehydration of the product. This contributes to less trimming, which reduces labor costs. With greater yields and less labor costs, wet aging can be more cost-effective than dry aging. During the process of wet aging, meat is usually stored at temperatures between 32 and 36° F. During storage, products can be boxed and stacked, reducing the amount of cooler space needed compared to dry aging, increasing production efficiency. For this reason, wet aging is the most common method of aging utilized by large meat processors. A disadvantage of wet aging is that this method can result in a slightly sour, metallic flavored product. However, as most large companies wet age products in the U.S. rather than dry age, the average consumer is accustomed to the flavor of wet aged product.

Which is better: Wet or Dry aged?

Both dry and wet aging improve product tenderness and neither method is more effective at improving tenderness than the other. The more important factors to consider include facility limitations and consumer preferences. Wet aging is easier for many processors. This is because it typically requires less cooler space for storage, there is less yield loss, and wet aging is less susceptible to changes in environment than dry aging. However, dry aged beef can be considered a premium product, with its unique characteristics, and some consumers prefer to buy it over wet aged.

Optimal Aging Time

As previously mentioned, one of the largest benefits of aging is tenderization. The majority of tenderness formation occurs from enzymes that are naturally present in the body. These enzymes in a living animal are responsible for breaking down muscle tissue following damage or for muscle turnover during growth, but after death they degrade muscle structure, resulting in tenderization. The optimal amount of time to age beef products is approximately 14 days. There is evidence that much of the activity of the primary enzymes that degrade muscle structure is complete by 7 days postmortem, with most of the consumer detectable improvements in tenderness being achieved by day 14 (Koohmarie and Geesink, 2006). Several studies concluded that tenderness of muscles in the loin did not significantly improve between 14 and 21 days of aging (Colle et al., 2015, Lepper-Blilie et al., 2015). Based on these results it is more efficient to age product for 14 days rather than 21 as product would be equally as tender without sacrificing as much product yield and cooler space. Product can be aged longer if desired to capture additional flavor development past 14 days. However, results are inconsistent, and some showed aging longer than 21 days increased metallic and rancid flavors which some consumers find undesirable (Colle et al., 2015).

Although aging does improve tenderness, it is important to acknowledge the how much of an improvement occurs. Tenderness can objectively be measured using various shear force methods. These methods involve cooking a cut of meat and using a machine to measure how much force it would take to cut through the meat, mimicking a human's bite. Previous research has identified the threshold of ~9.5 pounds of force as the threshold between tough and tender (Miller et al., 2001). In the last National Beef Tenderness Survey, all middle meat cuts evaluated were found to have a tenderness of less than 7 pounds of force and were classified as "very tender" (Gonzales et al., 2023)

What products should be aged?

Aging all cuts from a carcass is not necessary. It is recommended to age primals that are generally eaten as steaks, like the loin and the rib, as consumers expect and demand these to be tender. Other cuts such as roasts or portions of the carcass designated for grinding don't require aging as they will be tenderized using other means. For instance, a roast will become more tender throughout the cooking process. When a roast is cooked at a low temperature for an extended period of time with high moisture, the collagen holding the meat structure together breaks down, improving tenderness. Additionally, aging portions designated for ground products is unnecessary because they will undergo mechanical tenderization going through grinding.

Grain Finished vs. Grass Finished Beef

The majority of cattle in the United States are raised similarly with three stages of production: a cow-calf phase, a stocker (also called backgrounding) phase, and a finishing phase. Prior to weaning, calves are typically raised the same way on pasture consuming grass and milk. Some cattle then enter a stocker phase, which can be done in a feedlot or pasture setting and are fed a diet consisting of mostly grasses and forage before entering the finishing phase. Once the finishing phase is reached, grain-finished cattle eat a diet containing grains and forages for the 4-6 months prior to slaughter, while grassfed cattle remain on a strictly forage diet until harvest weight is achieved. Grain-finished cattle tend to achieve finishing weight faster due to a higher energy diet, while grass-finished cattle receive forage that is lower in energy, which slows growth (Berthiaume et al., 2006).

The demand for grassfed beef in the U.S. has been on the rise over the last five years. Grass fed beef sales increased 5% from 2020 and 2021 to an estimated value of $776 million (O'Brien et al., 2023). Consumers purchase grassfed beef for a variety of reasons including potential health and nutrition benefits, beliefs around animal welfare, and beliefs regarding environmental sustainability (Hati 2021, Loria 2022). The following section will compare both grass-finished and grain-finished beef.

Finishing Systems and Health

Human nutrition and health have been the largest drivers of increased grass-finished beef consumption in the U.S. (Umberger et al. 2009). Overall, grass-finished beef contains greater percentages of polyunsaturated fats like omega-3s and omega-6s that help promote brain function and heart health (Elswyk and McNiell, 2014). Grass-finished beef has also been found to contain fewer monounsaturated and saturated fats (Elswyk and McNiell, 2014). However, to truly compare grass-finished to grain-finished beef the overall fat content for each product needs to be considered. It is not uncommon for grass-finished beef to have less total fat than grain-finished beef, although there are programs that produce grass-finished beef with high amounts of marbling. Regardless, when grass-finished beef contains less total fat than grain-finished, a consumer would need to eat more beef to get the same equivalent of healthy fats (Elswyk and McNiell, 2014). Additionally, it is important to understand that not all mono-unsaturated and saturated fats are unhealthy. For instance, 1/3 of the saturated fat content in beef is stearic acid, which neutralizes low density lipoproteins (LDL; bad cholesterol) within the body. Meanwhile, there are many monounsaturated fats that that aid in flushing LDL from the body through the liver (Elswyk and McNiell, 2014). This means, while grain-finished cattle tend to have higher levels of fat, it is not all unhealthy fat.

While an animal's diet has been proven to influence fat development, various other factors influence fat development in meat such as stage of growth and breed. As an animal reaches physiological maturity, bone, nervous, and muscle development plateaus while fat development continues indefinitely. Although fat continues to develop, it is mostly in the form of subcutaneous (fat under the skin) and seam fat (fat between muscles) instead of marbling. This is because animals have a predetermined genetic limit to how much marbling they will develop. Certain breeds, like Angus, Jersey, and Wagyu, are genetically predisposed to deposit more marbling than others.

Another health benefit of grass fed beef is that it contains higher levels of antioxidants including increased beta-carotene and alpha-tocopherol. Beta-carotene is an important vitamin A precursor in the body, while alpha-tocopherol is a form of vitamin E. Antioxidants play a role in preventing oxidation, which can positively impact meat quality and shelf stability. Within the human body, antioxidants neutralize and deactivate free radicals found in the body that can damage DNA and cells. Because of this, it is believed they help slow aging, prevent heart disease, and help prevent cancer. Although there are some small differences between nutritional profiles of beef produced in either system, beef from either feeding system can be included in a healthy diet to meet consumers' needs.

Does Finishing System Impact Meat Quality?

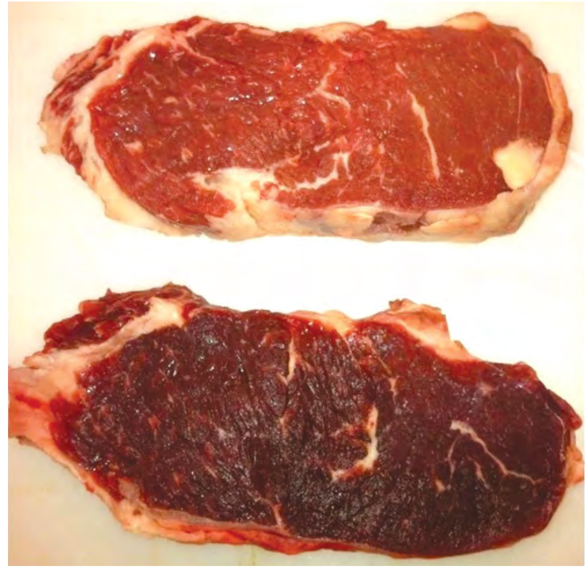
Studies have been conducted comparing tenderness between finishing systems with varied results. In a study conducted by Gomez and others (2022) grain-finished cattle, regardless of feed quality, produced steaks that were initially more tender than steaks from grass-finished animals when fed to a similar end weight. However, after a 14-day aging period, there were no differences in tenderness between grain or grass-finished cattle (Gomez et al., 2022). Further studies have found no differences in tenderness between grain and grass finished cattle. Duckett and others (2013) found that steaks from grain and grass-finished cattle fed for the same number of days had no differences in tenderness after 14 days of aging. An additional study was comparing grain and grass-finished cattle fed to the same finishing weight and fat thickness exhibited no differences in tenderness (Muir et al., 1998).

A variety of factors can influence differences in tenderness. The first is animal age. Grass-finished cattle take longer to achieve their final finishing weight, and on average can spend an additional 2-6 months on feed compared to grain-finished cattle. As an animal ages, there is an increase in toughness from the crosslinking of connective tissue in the muscle. Crosslinking is the development of rigid connective tissue over time. This occurs naturally throughout the body but can be exacerbated with injury and exercise. Therefore, tenderness differences between grain-finished and grass-finished beef could be a result of age differences at harvest, and thus connective tissue content in the body. Another factor that can influence tenderness is breed. Meat from bos indicus cattle such as Brahman and Nellore, tends to be less tender than meat from bos taurus cattle such as Angus and Hereford (O'Connor et al., 1997). This can be contributed to bos indicus cattle exhibiting reduced activity for enzymes responsible for protein degradation in a postmortem system (Scheffler, 2022). The final factor influencing tenderness that will be discussed in this text is the impact of animal sex. Steers tend to be more tender than heifers (Tatum et al., 2007). This difference in tenderness was determined to be a result of specific differences in enzyme activity responsible for protein degradation within the muscles. Heifers were found to have greater levels of enzymes that prevented protein degradation from occurring within the first 24 hours postmortem in the loin muscle. This means there was less breakdown of protein structure within the muscles of heifers, reducing tenderness, compared to steers (Wulf et al., 1996, O'Connor et al., 1997).

Animal diet also has the ability to influence the color of fat on the carcass. Grain-fed cattle develop bright white colored fat, while grass-finished cattle deposit yellow fat. This yellow colored fat is caused by the antioxidant beta-carotene from the forages consumed (Dunn et al., 2009). Although this yellow fat has an undesirable appearance to some American consumers, greater levels of beta-carotene contribute to desirable health properties such as slowed aging, slowing heart disease, and preventing cancer.

Finally, notable flavor differences have been identified between the two finishing systems. A study conducted a sensory evaluation of grain- and grass-finished steaks utilizing a population of consumers. Within that study, grass-finished beef was described to have increased negative flavors associated with beef such as barny (a flavor associated with manure), bitter, gamey, and grassy compared to grain-finished beef. It was also concluded that grain-finished beef exhibited increased flavors of juicy and umami, also known as savory and that the grain-finished beef samples were more 'liked' than the grass-finished samples (Maughan et al., 2012). While grain-finished beef exhibited less negatively associated flavors, it is important to note not all consumers view flavors the same, and ultimately 'liking' of product comes down to individual consumer preference and experience.

Dark, Firm, and Dry (Dark Cutters)



Dark cutters are the result of chronic stress while the animal was still alive. Chronic stress can be as short as a few days or much longer. Factors that can cause chronic stress include estrus in heifers (the time of the reproductive cycle when a female can be bred), heat or cold stress, sickness, injury, or situations where the animal is distressed such as being separated from herd mates or taken to a new environment. These stressful situations cause the animal to be in a constant fight or flight state, which uses a lot of the animal's stored energy. When an animal is harvested before those energy stores can be replenished, this deficiency prevents a carcass from going through the normal rigor mortis process that involves production of lactic acid from the muscles which will reduce the pH of muscle from 7 to the normal pH of meat of ~5.5. Because the pH doesn't drop as much in carcasses of chronically stressed cattle, the meat from that carcass will stay much darker than normal meat and will not bloom in the presence of oxygen. In the picture, the top steak has a normal pH for beef, while the bottom steak is a dark cutter with a higher than normal pH. While dark cutting meat is safe to eat, it can have a slightly soapy flavor, may appear raw after cooking, and has a shorter case life due to the increased pH.

Blood splash

Blood splash is a quality defect in meat which occurs when capillaries or blood vessels burst within muscle during the harvest process. The main cause for this is unknown. However, weak capillaries, high blood pressure, a long stun to stick interval, and electrical stunning can contribute to this defect. Meat with blood splash is safe to consume, but typically in a commercial setting it is placed into trim due to its unappealing appearance for consumers. The picture shows blood splash in a ham.

Purge

Purge is the red liquid commonly found in the bottom of meat packaging. Purge is often mistaken as blood. However, it is mainly water and the protein myoglobin (which contributes to the red color of meat) leaking out of the product. Fresh meat is composed of about 75% water. There are a few factors that impact purge loss including pH, muscle cell integrity, and product handling. Any damage to muscle cells may contribute to an increased incidence of purge. Examples of damage include cutting and freezing. By cutting the product, muscle cells become damaged, creating leak points within meat's structure. This enables water and myoglobin to escape, increasing purge loss. Furthermore, when meat is frozen, the water molecules within the muscle cells crystallize and expand, damaging the structure of meat in the process. When the product is then thawed, the damaged cells leak greater amounts of moisture.

Although purge is not appealing to look at within a package, it cannot be eliminated completely, but it is not a food safety issue. Purge loss does, however, have the potential to negatively impact overall yield and meat quality traits like juiciness and color. Increased purge loss equates to loss of product yield. The more water is that is lost, the more weight the product loses. Additionally, the more water lost from the product, the less juicy it will be, resulting in a less desirable eating experience. Moreover, increased purge loss is associated with increased myoglobin loss, which can result in a paler colored product which can be undesirable for consumers.

Frozen Meat Products

A common belief is that frozen meat is lower quality than fresh meat. However, studies have found that freezing meat products can help improve the likelihood of obtaining a more tender cut. A study investigating the impact of freezing strip loins found that there was increased tenderness in previously frozen product versus fresh product (Beyer, 2023). This increase in tenderness is likely due to muscle cells expanding during the freezing process because of the high-water content within the meat. As ice crystals form within the muscle cells causing the muscle cells to expand and tear, damaging the muscle structure. This damage to the muscle structure contributes to improved tenderness, but can also contribute to increased instance of purge loss, decreasing juiciness. This was confirmed by a trained sensory panel that found non-frozen samples had increased juiciness and reduced purge loss compared to the previously frozen samples (Beyer, 2023). Therefore, the freezing process can improve meat tenderness, but at the cost of increased purge and potential loss of juiciness to products.

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