Cattle & Carcass TRAINING

The Science Behind the Grade

USDA United States Department of Agriculture

Cattle & Carcass TRAINING

The Science Behind the Grade

How biology and physiology impact production, performance, and carcass quality and acceptance.

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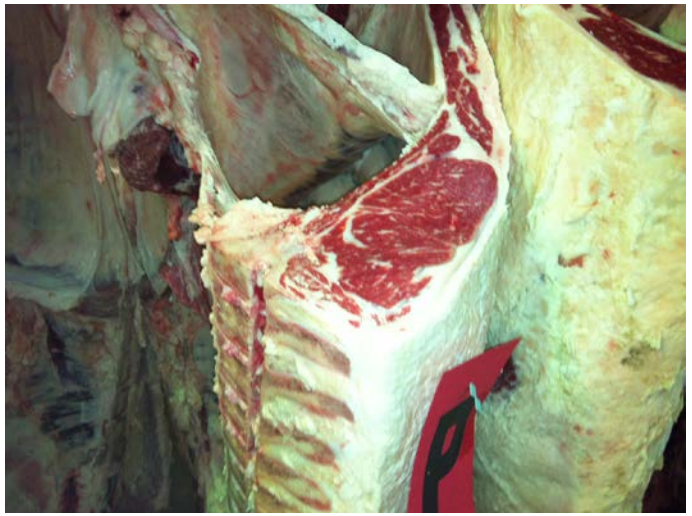
USDA United States Department of Agriculture

Envision a high-quality beef experience



ANIMAL SCIENCES
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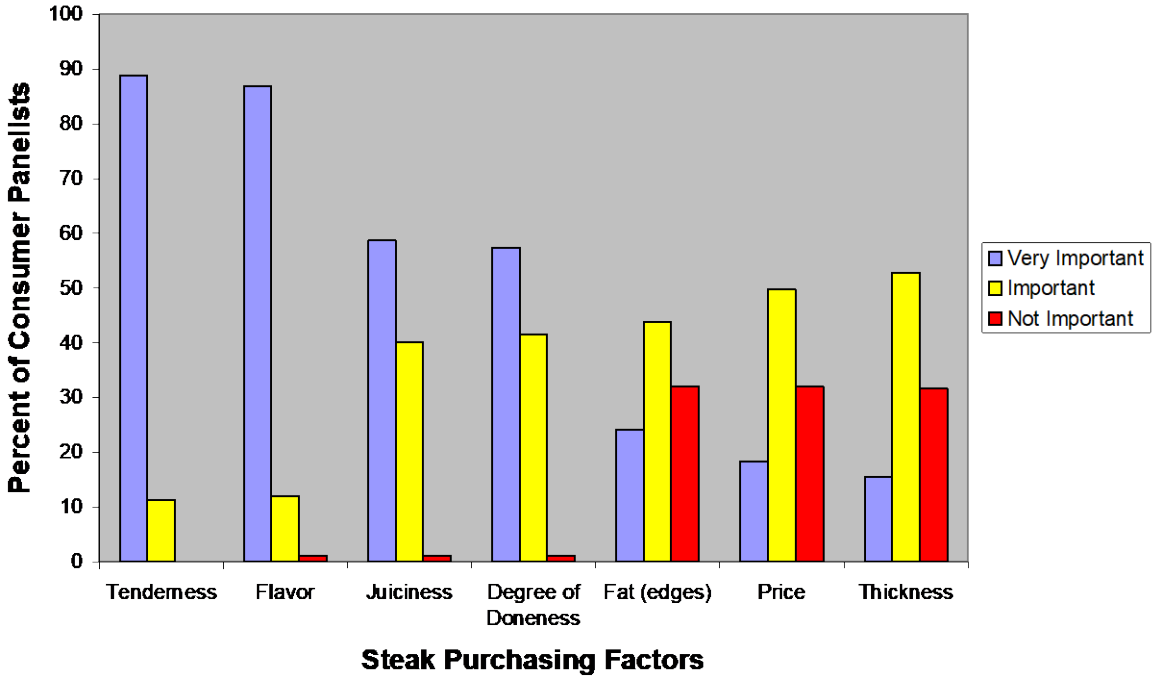
Beef Quality

Intrinsic Traits

- Palatability Traits (tenderness, juiciness, flavor)
- Safety
- Nutrition
- Appearance



Extrinsic Traits

- Price
- Production strategy
- Socio-cultural values (welfare, sustainability, etc.)

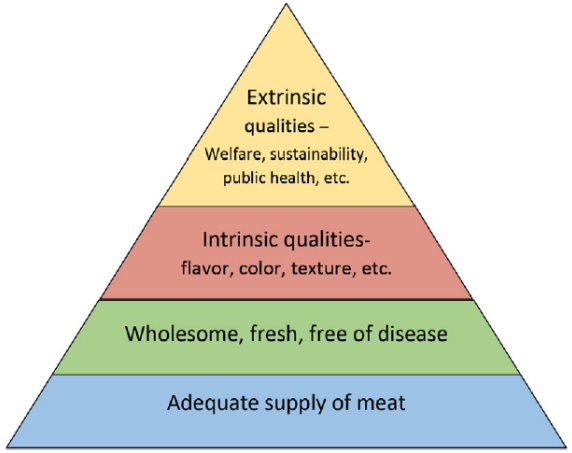


FIGURE 1.1 Consumer perceptions of meat quality represented as a "triangle of needs," that is, that the more basic needs or desired quality elements at the bottom levels of the triangle need to be more or less satisfied before higher-level quality attributes become important.

Focus on Palatability

Palatability Traits

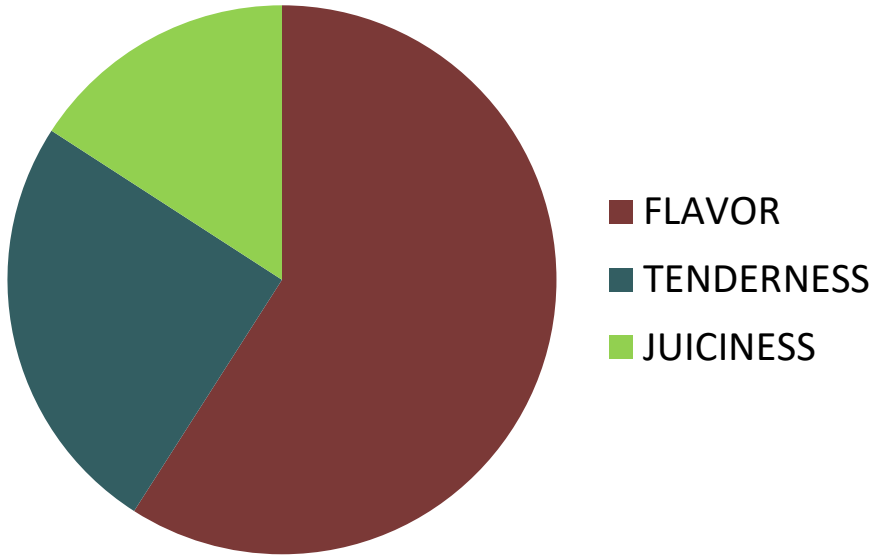
- Tenderness
- Flavor
- Juiciness

National Beef Quality Audit Summaries

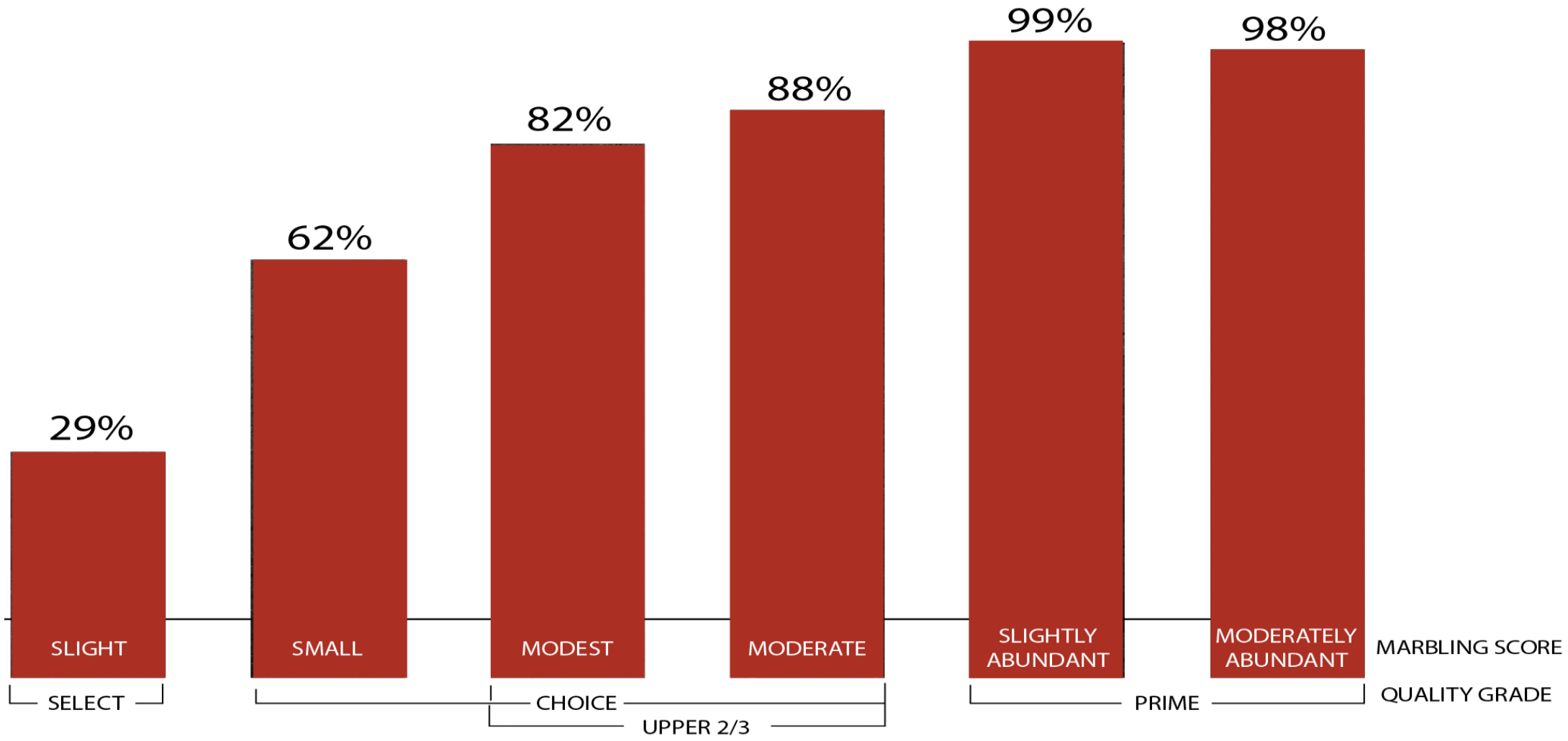
1991	1995	2000	2005	2011	2016
External Fat	Overall Uniformity	Overall Uniformity	Traceability	Food Safety	Food Safety
Seam Fat	Overall Palatability	Carcass Weights	Overall Uniformity	Eating Satisfaction	Eating Satisfaction
Overall Palatability	Marbling	Tenderness	Instrument Grading	How and Where Cattle were Raised	Lean Fat and Bone
Tenderness	Tenderness	Marbling	Market Signals	Lean Fat and Bone	Weight and Size
Overall Cutability	External and Seam Fat	Reduced Quality Due to Use of Implants	Segmentation	Weight and Size	How and Where Cattle were Raised
Marbling	Cut Weights	External Fat	Carcass Weights	Cattle Genetics	Visual Characteristics

What do we know about palatability?

- Tenderness is ***essential*** for consumer acceptance
  - >90% of steaks are considered tender or very tender
- Flavor may be equally important to tenderness
  - 58% of consumers say flavor is ***more important*** than tenderness
  - 43% of consumers say tenderness is ***more important*** than juiciness



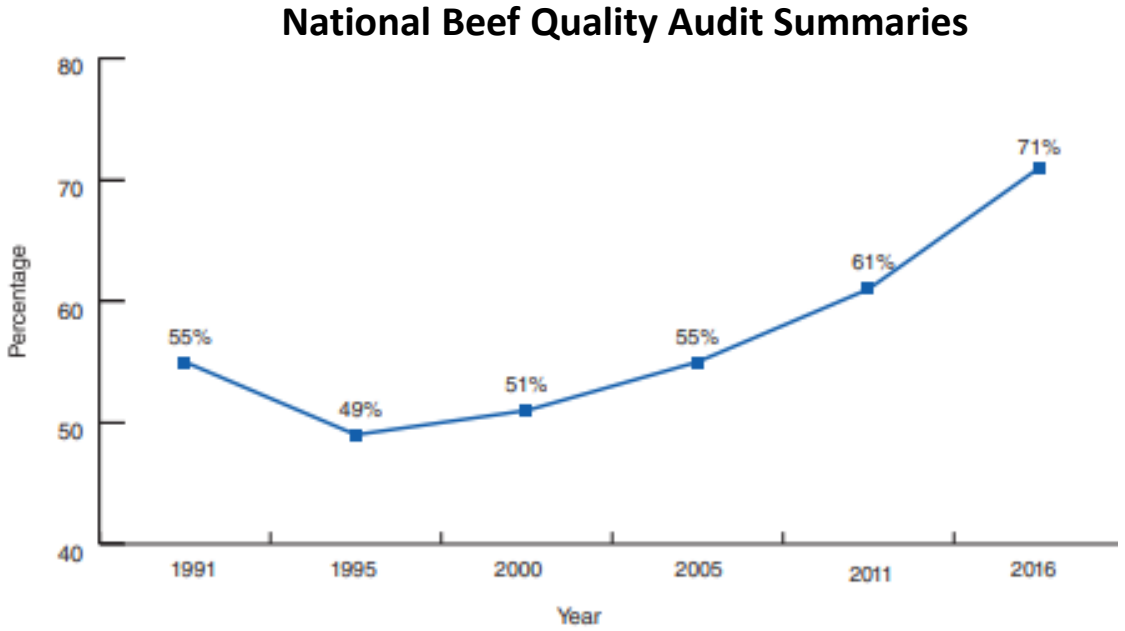
Focus on Palatability



Colorado State University M.S. Thesis: M.R. Emerson (2011), Animal Sciences Colorado State University

If marbling is highly associated with a positive eating experience…

…let's just produce all Prime beef

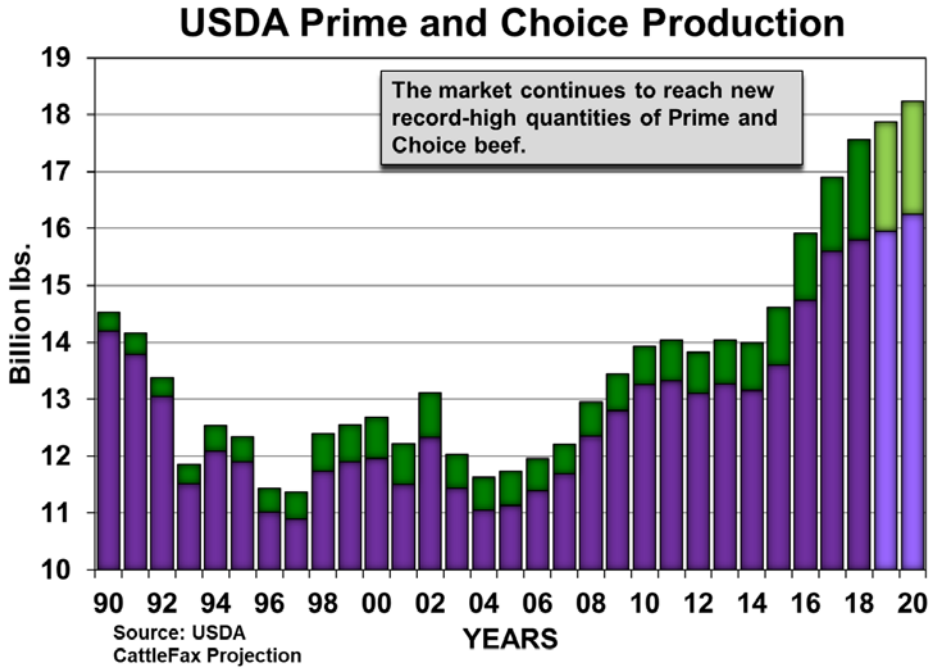


U.S. Quality Grade Improvement

Fed Cattle Grading Percentage

	2005	2019	Change	% Change
Prime	2.8%	8.6%	5.8 pts	+207%
Upper 2/3 Choice	13.8%	23.4%	9.6 pts	+70%
Certified Angus Beef ®	15.6%	35.1%	19.5 pts	+125%
Lower 1/3 Choice	39.1%	48.2%	9.1 pts	+23%
Choice	52.9%	71.6%	18.7 pts	+35%
Select	36.5%	16.8%	-19.7 pts	-54%

Source: USDA, CattleFax



May 2019:
8% Prime

May 2020:
11-12% Prime

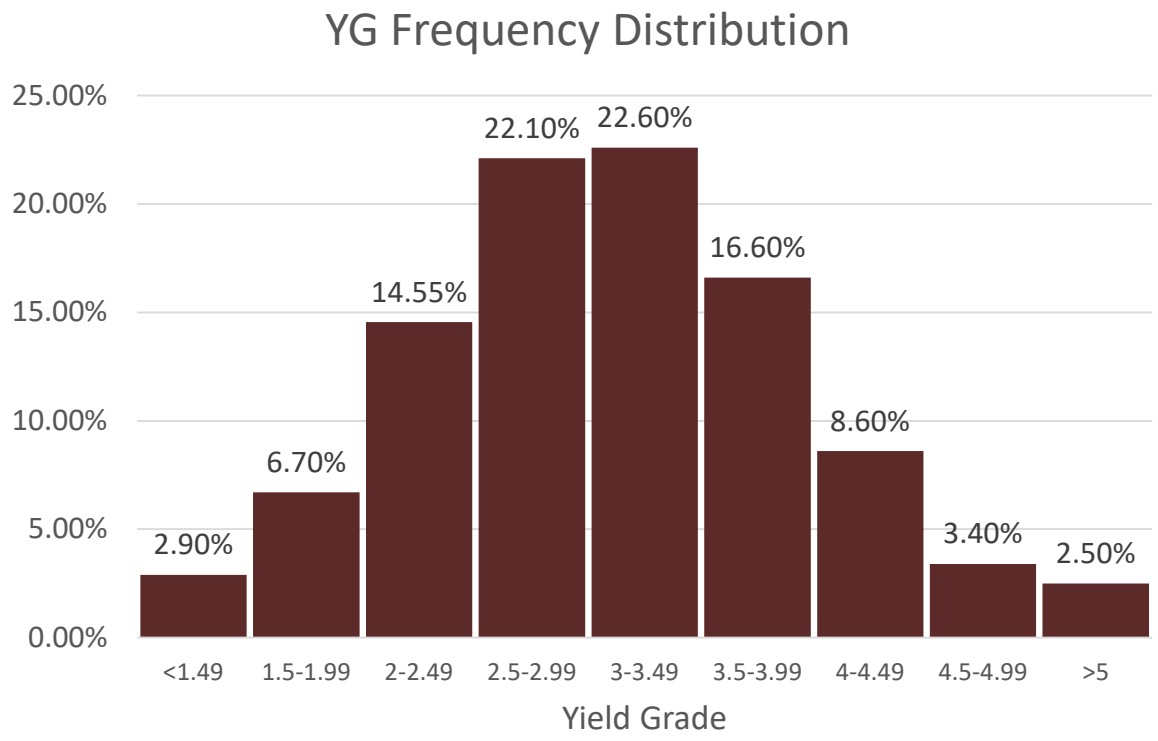
Producing High Quality Beef is an Art…

…and a balance

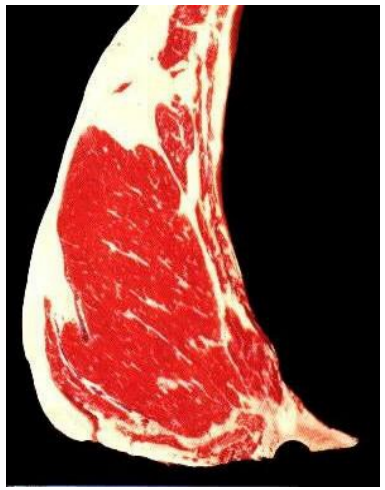
National Beef Quality Audit Summaries

Trait	1991	1995	2000	2005	2011	2016
USDA YG	3.2	2.8	3.0	2.9	2.9	3.1
USDA QG	686	679	685	690	693	696
Fat thickness, in	0.59	0.47	0.47	0.51	0.51	0.56
HCW, lbs	760.6	747.8	786.8	793.4	824.5	860.5
LM area	12.9	12.8	13.1	13.4	13.8	13.9

Trend of greater high-quality carcasses has been met with trend of increasing Yield Grade and HCW



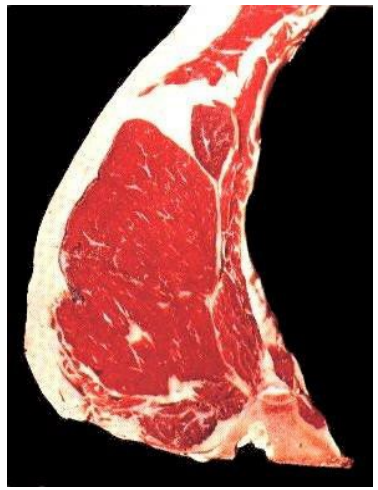
Balancing Quality with Yield



YG-1

+$3.79/cwt

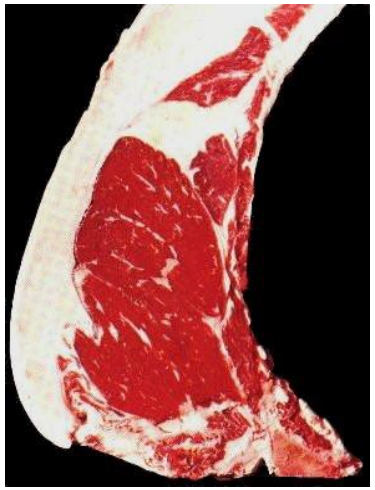
QG	%
Prime	0.07
Choice	4.06
Select	4.79
Other	0.55



YG-2

+$1.86/cwt

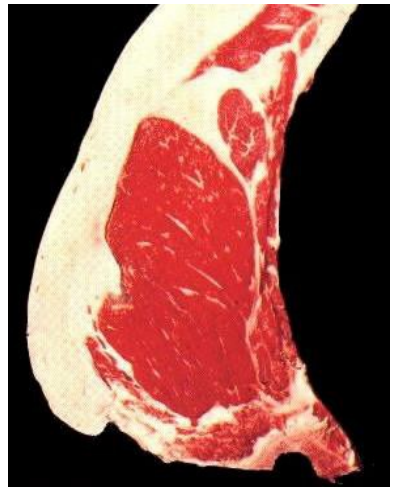
QG	%
Prime	0.94
Choice	23.61
Select	10.90
Other	1.05



YG-3

Par

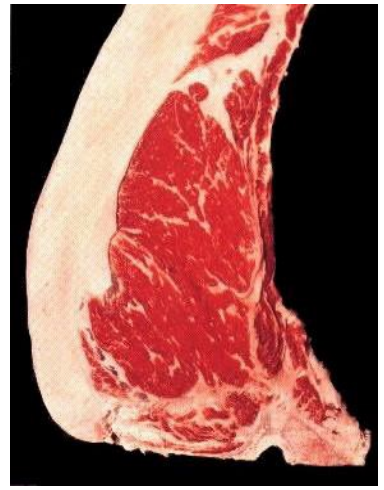
QG	%
Prime	1.78
Choice	29.94
Select	6.20
Other	1.49



YG-4

-$11.64/cwt

QG	%
Prime	0.97
Choice	9.31
Select	1.40
Other	0.40



YG-5

-$17.21/cwt

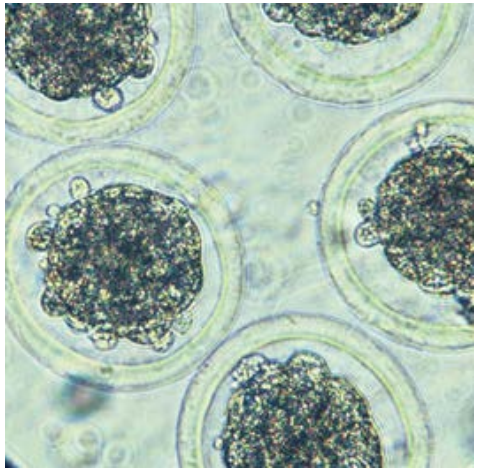
QG	%
Prime	0.22
Choice	1.86
Select	0.33
Other	0.12

Producing High Quality Beef is an Art…

…and a science

In order to balance eating quality and yield, we must understand…

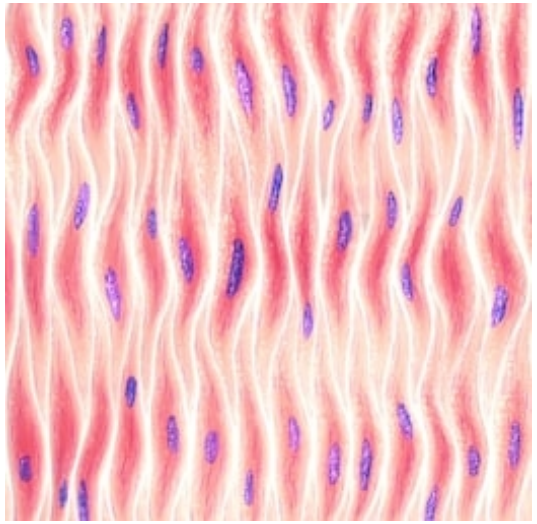
- The science of muscle, fat, and skeletal development
- The variables influencing carcass performance and eating quality



Building High Quality Beef

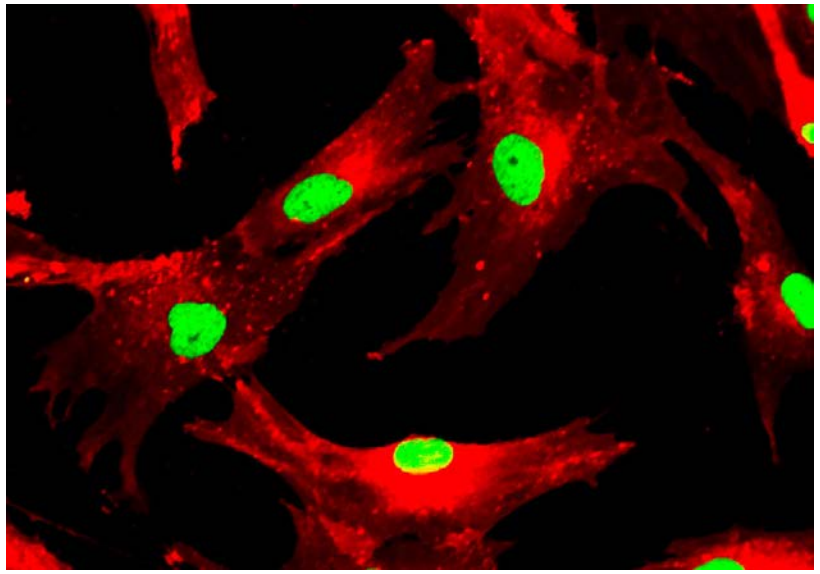
Starts at the Cell
Ends at the Rail

From the Cell to the Rail

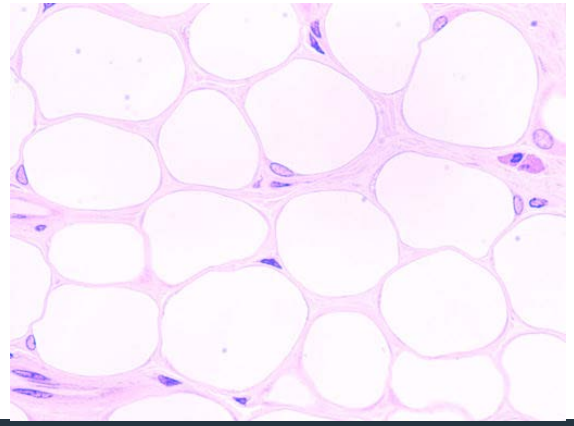


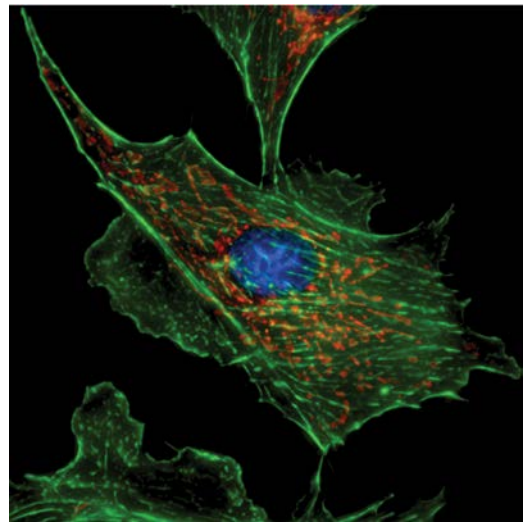
Myocytes

Mesenchymal Stem Cells



Adipocytes





Fibroblasts

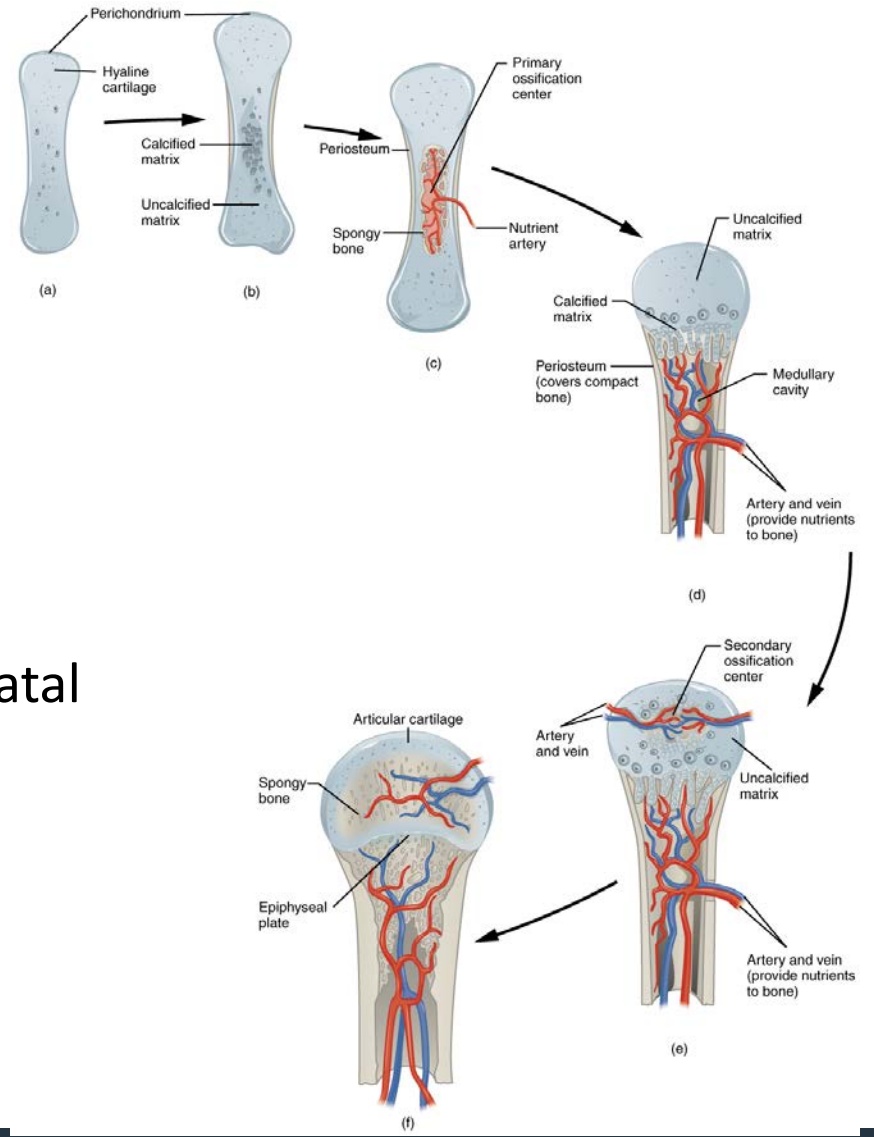
Science of Skeletal Development

High quality cattle begin with good skeletal structure

- Similar to the foundation of a house
- Bones serve as levers for skeletal muscles

Skeletal structures form prenatally

- Bone formed from mesoderm layer
- At birth, bone content is high (2:1) → decreases as animal grows
- Nutrition, use, hormones, and management can influence post-natal skeletal development and bone growth
    - *Calcium and functional use influence bone growth*
    - *Castration and estrogen exposure inhibit bone growth*



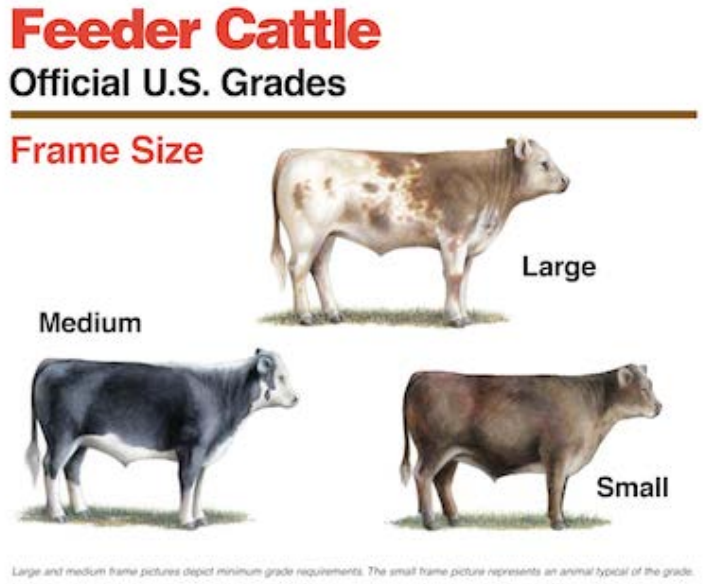
Science of Skeletal Development

Post-Natal Skeletal Changes

- Bone growth occurs longitudinally
  - Longitudinal growth occurs at the epiphyseal plate--ossification
  - Amount of bone growth depends on:
    - *Rate of new cell production*
    - *Size of cells before ossification*

Why Does Skeletal Development Impact Beef Quality?

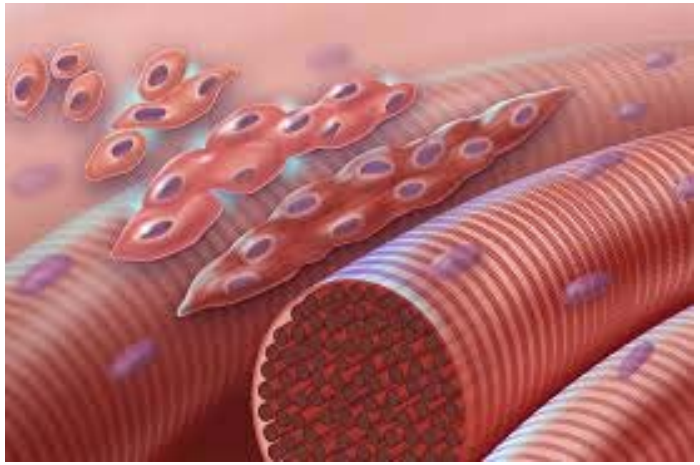
- Skeletal system creates foundation for muscle development
- As bones grow longitudinally→ muscles grow
- Large frame size usually attributed with faster rate of lean meat growth (tend to be later maturing)
- Large-framed cattle produce learner beef



Science of Muscle Development

Muscle development begins in early gestation

- 1st two months → primary muscle cells develop
- 2 through 8 months → secondary muscle cells→ ***majority of skeletal muscle***
- ***Number of skeletal muscles cells is largely set by month 8 of pregnancy***
- Skeletal muscle isn't priority for energy partitioning (brain, heart)
- After birth, muscle growth is **hypertrophic** (growth in size)



What does this mean?

- ***Prenatal factors*** influence skeletal muscle development
- Management of cows mid-gestation correlated with muscling
    - Poor nutrition during gestation = light muscling, low yield

Science of Muscle Development

Postnatal Muscle Changes

- At birth, focus is on small muscles associated with the skeleton
  - ***Necessary for biological functionality***
- After birth, substantial changes in muscles not associated with the skeleton
  - Reflection of use, location, nutrition, etc.

Differences in Muscle Fiber Type

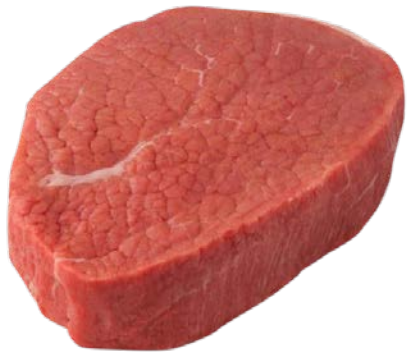
- Primarily Type I fibers at birth
- Transition to glycolytic metabolism
- Changes influenced by:
  - Use
  - Breed-type
  - Nutritional plane

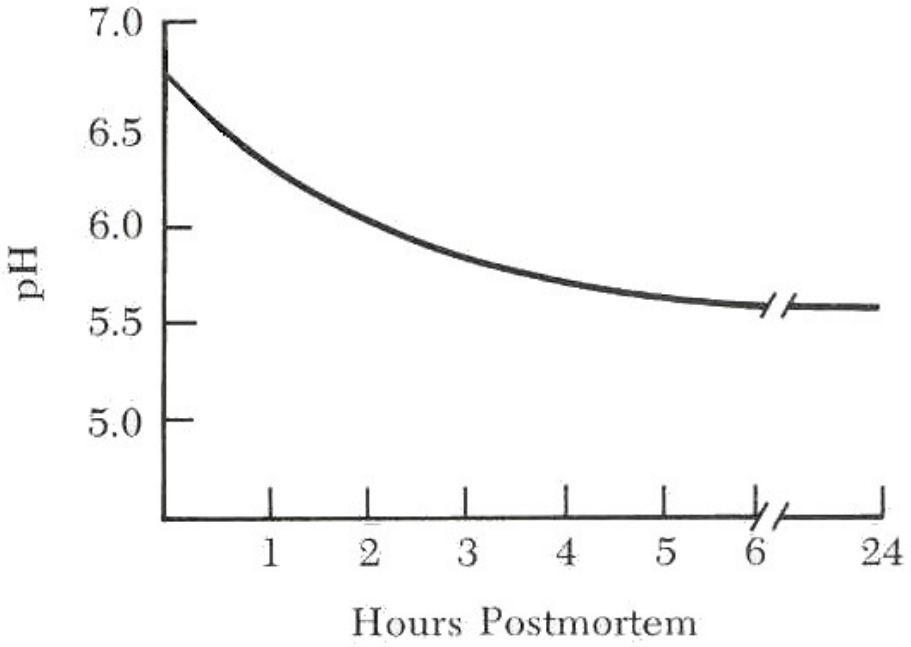
Trait	Type I	Type IIA	Type IIX
Metabolism	Oxidative	Oxidative & Glycolytic	Glycolytic
Speed	Slow	Medium	Fast
O2 Requirement	Aerobic	Aerobic	Anaerobic
Size	Small	Small	Large
Lipid Content	High	High	Low
Myoglobin	High	High	Low
Fatigue Resistance	High	High	Low
Mitochondrial Activity	High	High	Low
Color	Red	Intermediate	White
Example	Diaphragm	Psoas major	Chuck/Round

Science of Muscle Development

Muscle fiber type and metabolism impact a variety of beef quality factors:

- Ultimate pH Decline
- Marbling (Type I Fibers ↑ Marbling)
- Tenderness (cross sectional area, use)
- Water Holding Capacity
- Color





Science of Fat Development

Lipid cells develop in late gestation and early postnatal period

- Overlap between adipogenesis and secondary myogenesis
- Lipid cell development follows a sequential order:
    - Visceral → subcutaneous → intermuscular → intramuscular

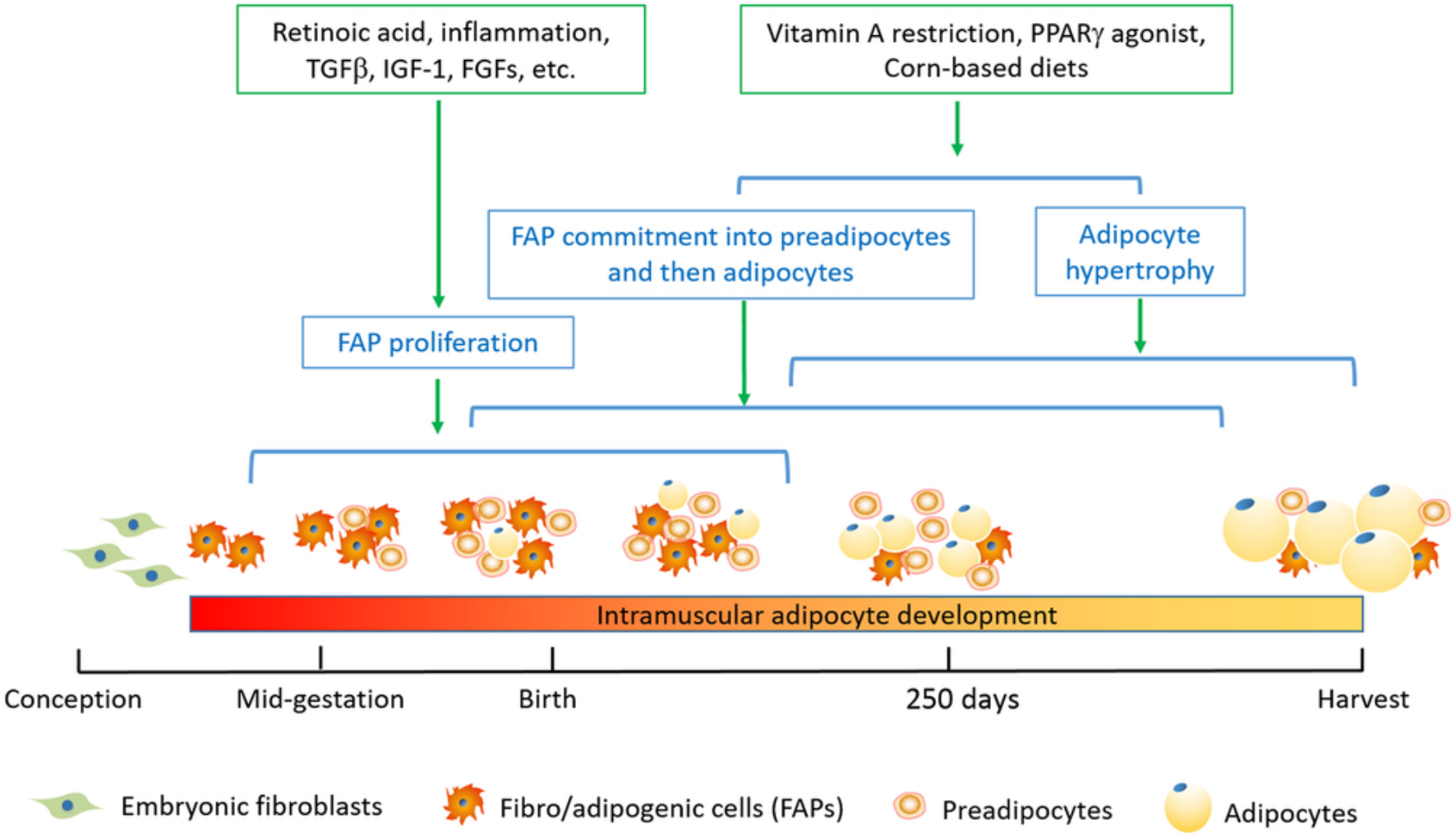
Adipose cells are clustered in connective tissue or within/between muscle bundles

- Intramuscular adipocytes exist between primary/secondary muscles bundles (perimysium)
- Lipid-storing ability of intramuscular adipocytes lower than subcutaneous adipocytes

Given the value of marbling, significant efforts to understand intramuscular fat

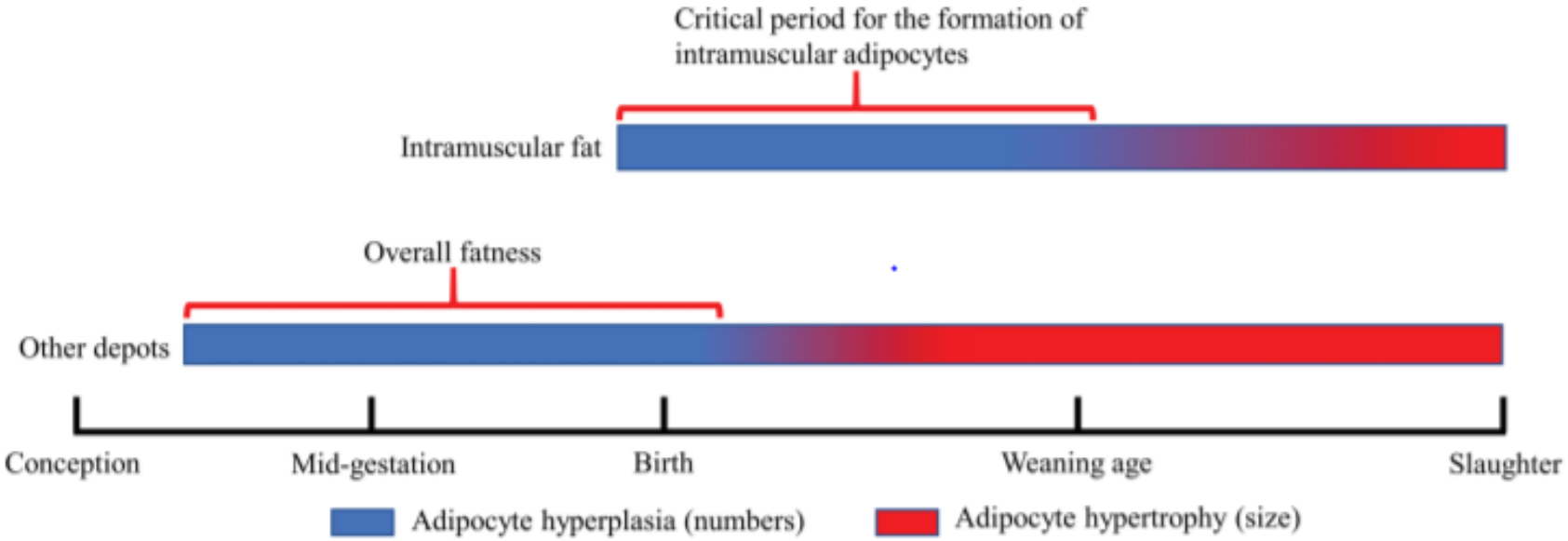
- Fibro-adipogenic progenitors → the foundation for intramuscular fat development

Science of Fat Development



Li et al., 2020

Science of Fat Development



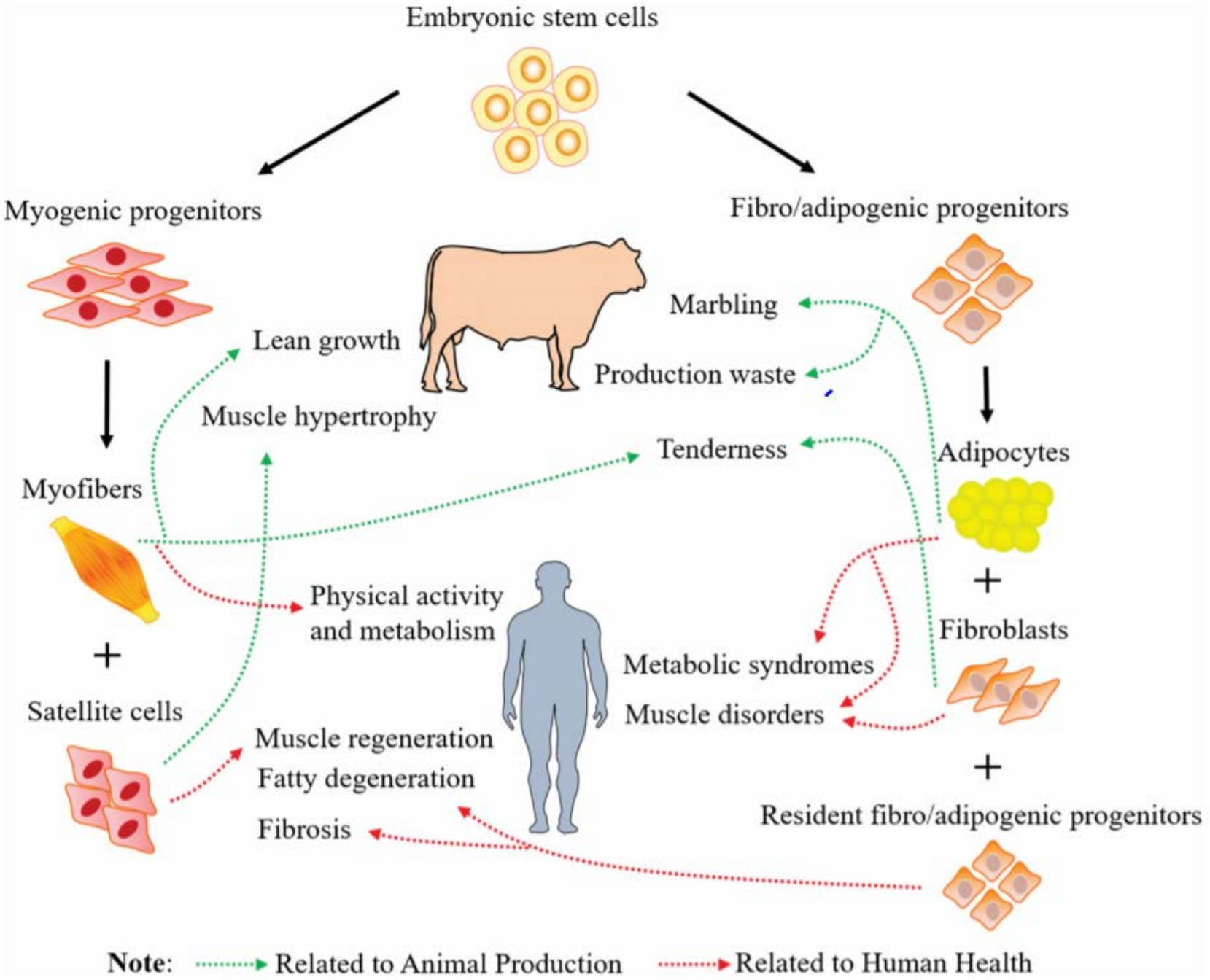
Subcutaneous Fat

- Develops early
- More mature
- Acetate Required

Intramuscular Fat

- Develops later
- Less mature
- Glucose required

Zhao et al., 2019



Zhao et al., 2019

Building High Quality Beef

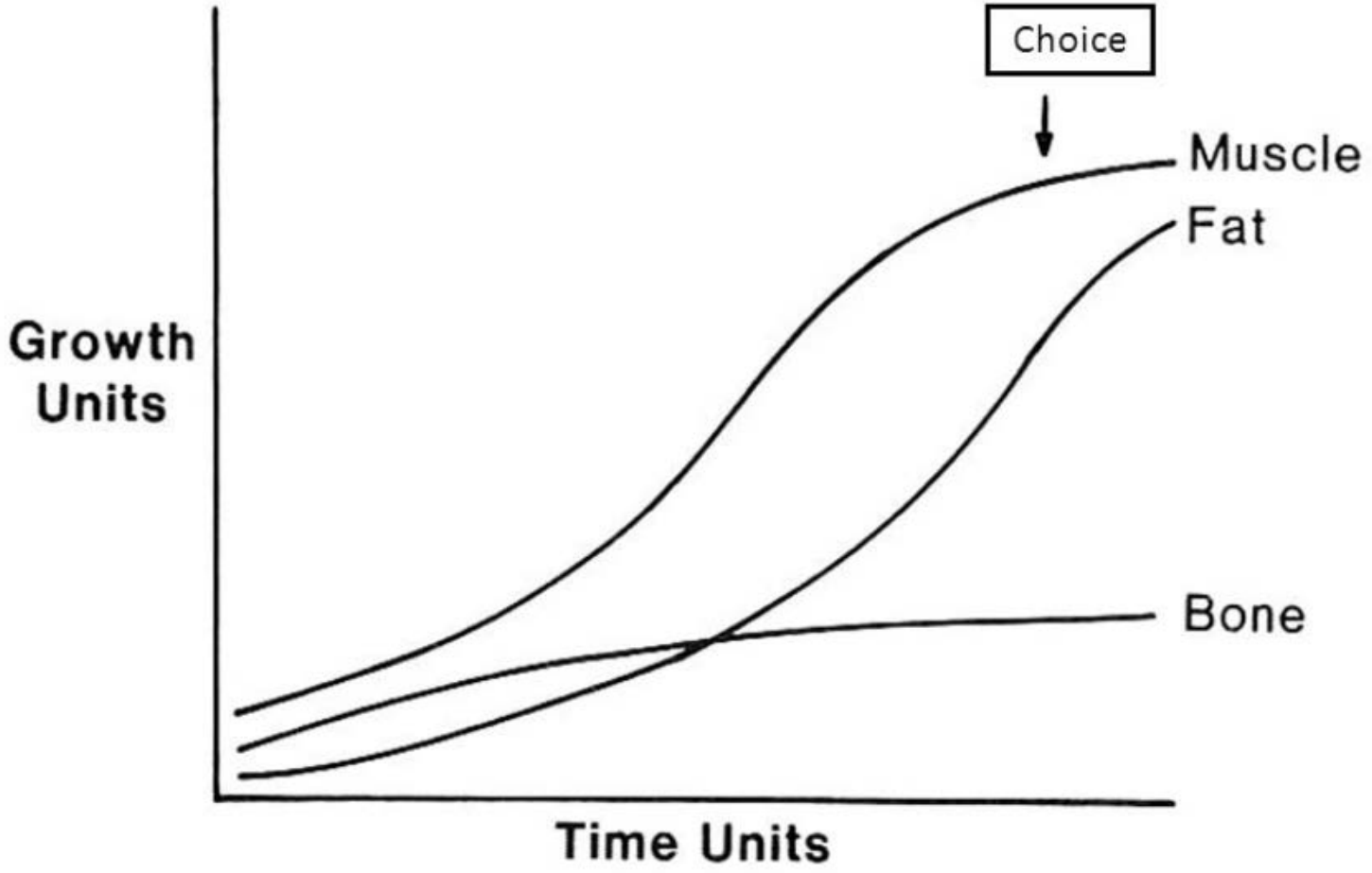
Starts at the Cell
Ends at the Rail

Balancing Postnatal Changes

As animal matures, muscle growth slows and is replaced by fat deposition

Fat deposition is energy inefficient

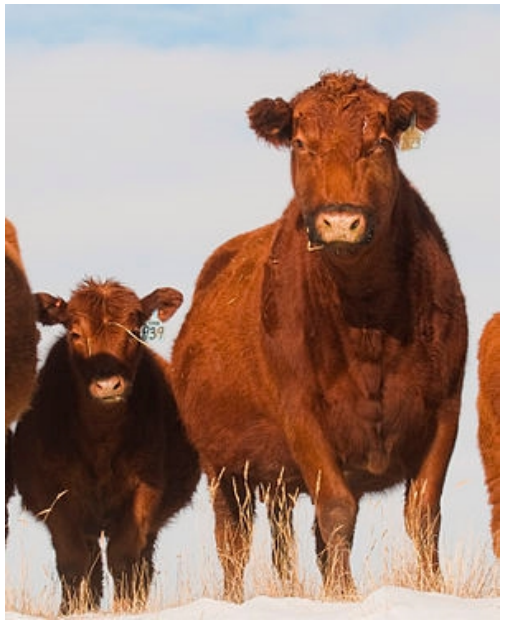
- Especially IMF

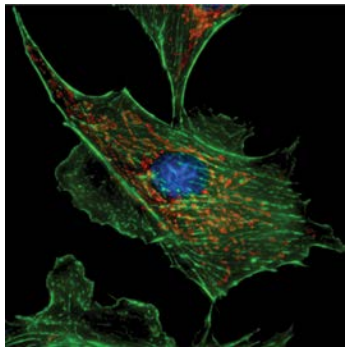


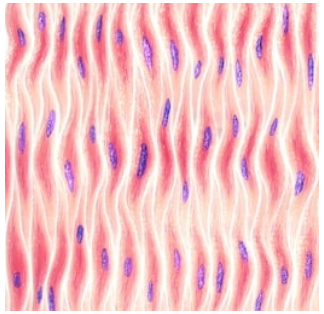
Producing High Quality Beef is an Art…

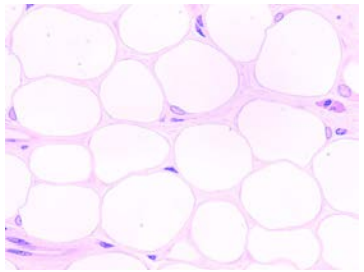
…a Science

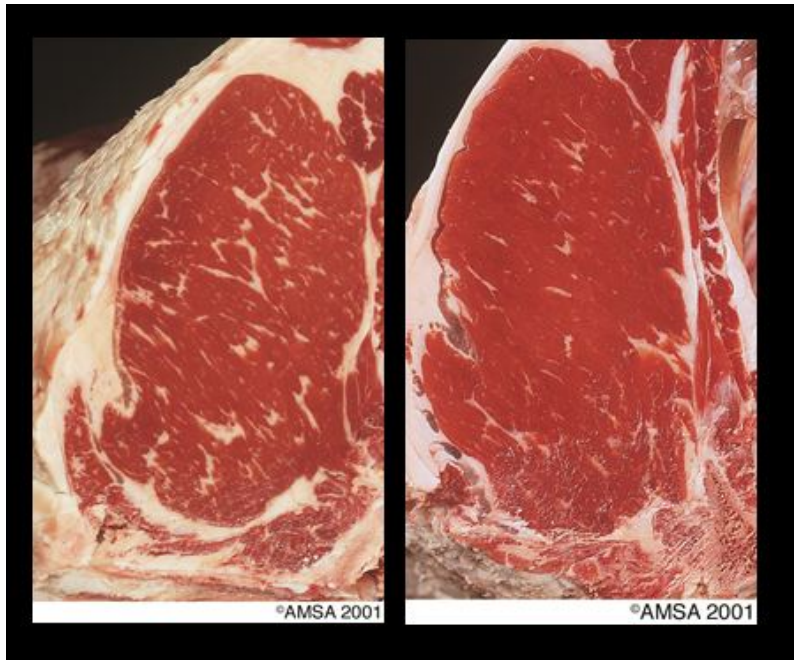
…a Balance











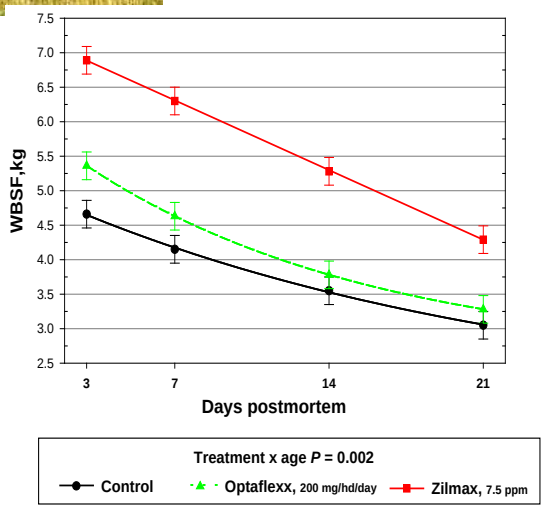
Managing Variables that Impact Quality

Pre-Harvest Factors

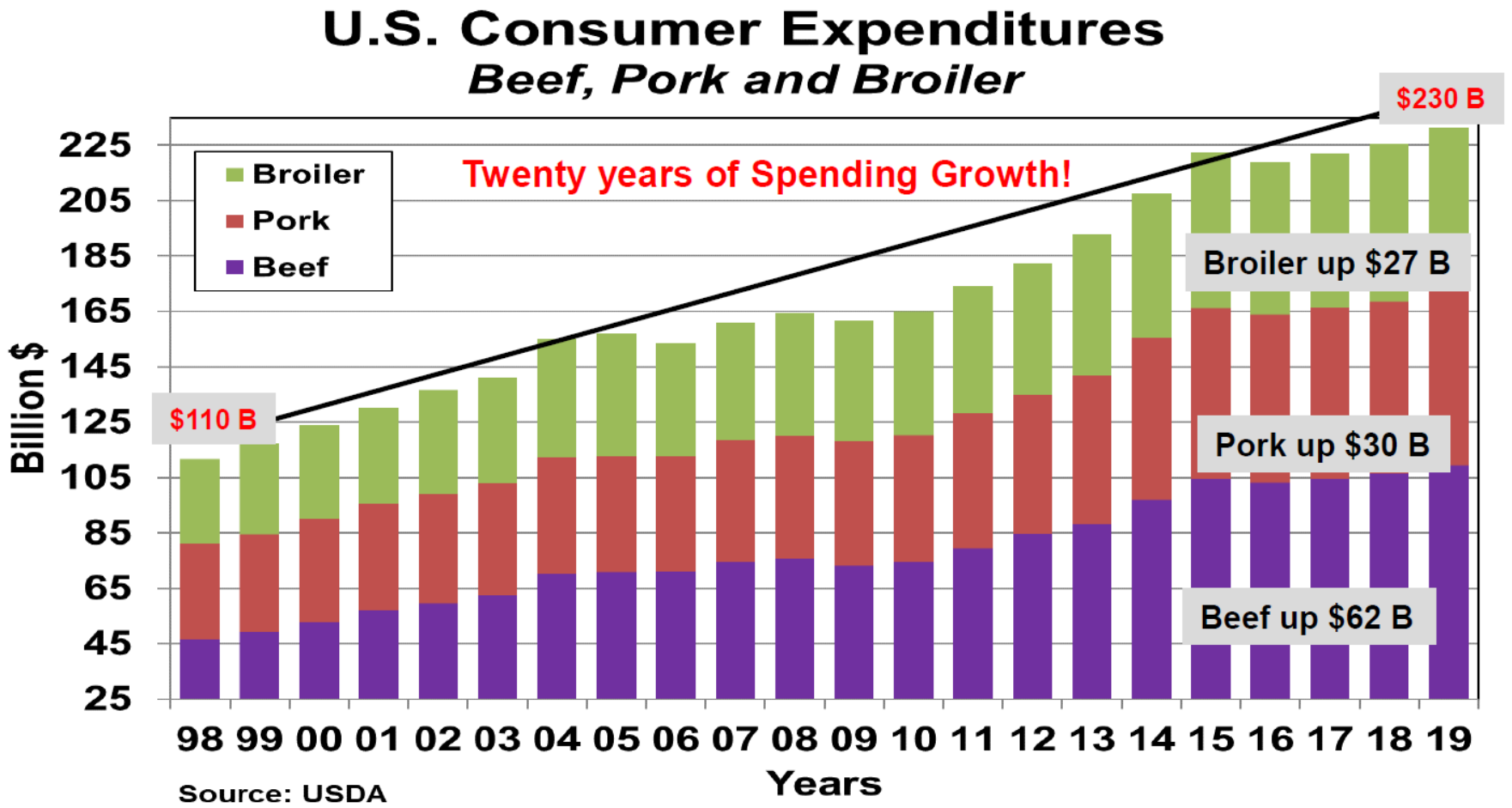
- Breed or breed-type (*Bos indicus* vs. *Bos Taurus*)
- Prenatal Nutrition
- Age of animal
- Stress prior to harvest
- Production systems
- Performance technologies (i.e. Beta-agonists, implants, etc.)

Post-Harvest Factors

- In-plant practices (chilling, temperature, etc.)
- Aging method (wet vs. dry aging)
- Aging length
- Packaging
- Cooking/Preparation



Producing High Quality Beef is Essential



CattleFax | THE DECIDING FACTOR

Consumers *demand* a high-quality eating experience.

As price increases, demand for high-quality and consistency will also increase…

…so what?

Building High Quality Beef

Starts at the Cell
Ends at the Rail

Understand the Science
Respect the Art
Perfect the Balance

Cattle & Carcass TRAINING

The Science Behind the Grade

How science affects the grade

Dr. Bucky Gwartney
International Marketing Specialist
USDA – Agricultural Marketing Service

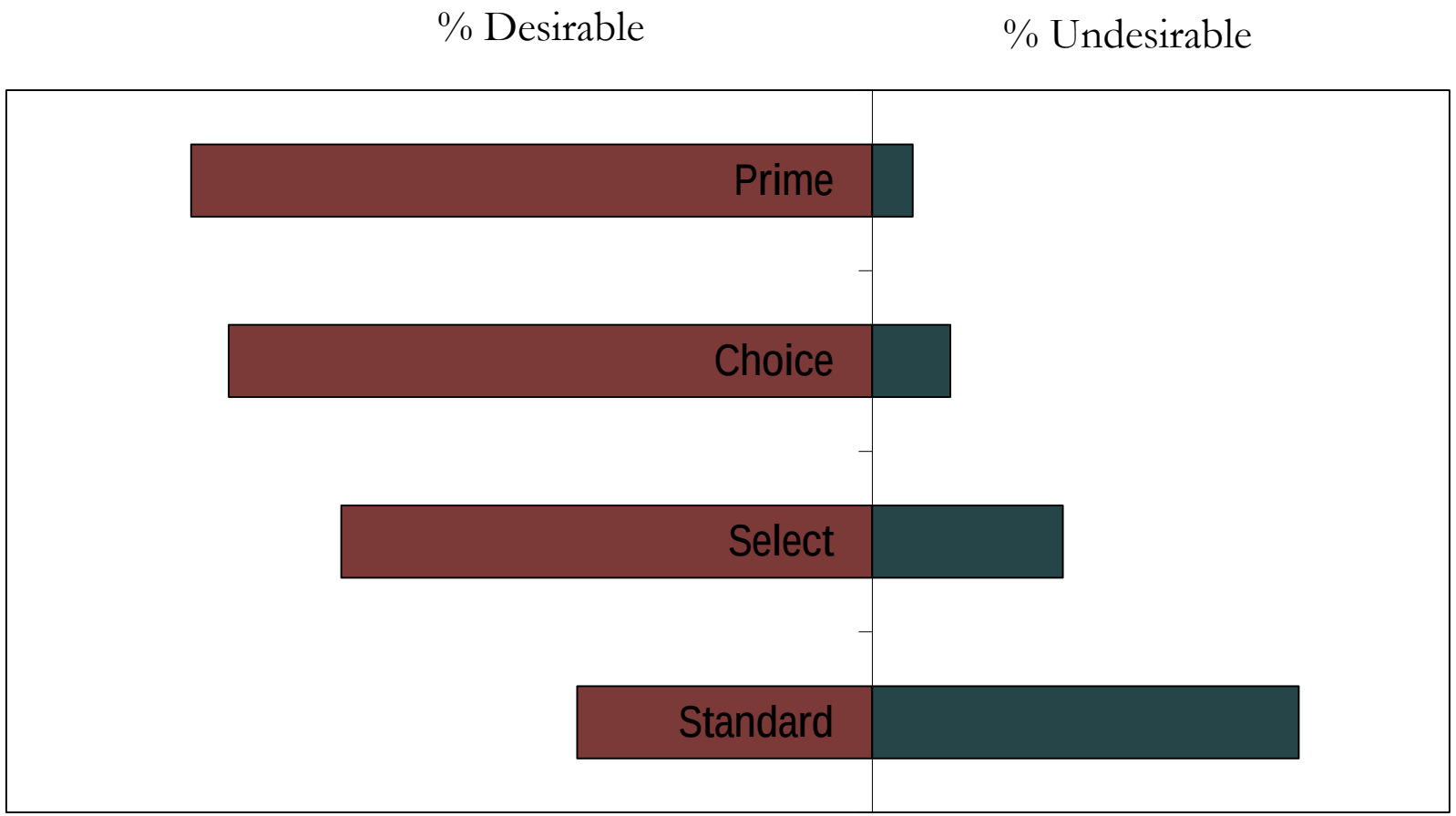
USDA United States Department of Agriculture

Science and the Grade Application

- Quality grade—characteristics of the meat that predict the **palatability** of the lean

- Yield grade—indicates the **yield of closely trimmed, boneless retail cuts** expected to be derived from the major wholesale cuts (round, sirloin, short loin, rib, and chuck)

USDA Quality Grade



Adapted from Smith et al., 1987. Journal of Food Quality 10:269-286

Quality Grade Determination

- Sex Classification
- Maturity evaluation based on evidences of skeletal maturity and color and texture of ribeye muscle (between 12th & 13th rib). Only if over 30 months.
- Marbling and Firmness of Ribeye Muscle (between 12th & 13th rib)

Quality Grade Determination

- Sex Classification – Bulls vs Steers vs Heifers
  - Intact males (Bulls) deposit less marbling but are higher muscled
  - Castrated males (steers) deposit more marbling but are less muscular
  - Females (heifers) tend to be a little fatter and lighter than steer carcasses

Quality Grade Determination

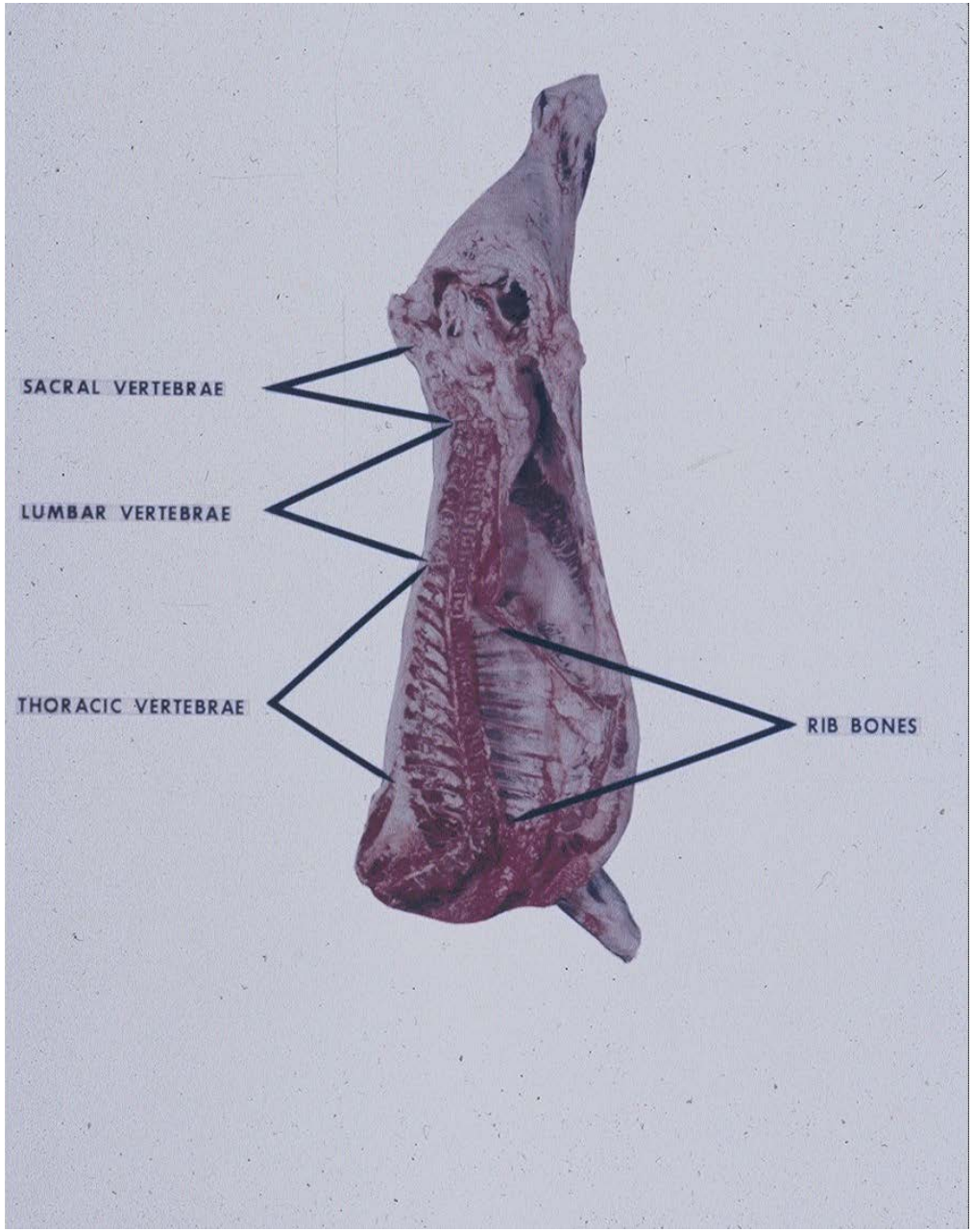
- Sex Classification
- Maturity evaluation based on evidences of skeletal maturity and color and texture of ribeye muscle (between 12th & 13th rib). Only if over 30 months.
- Marbling and Firmness of Ribeye Muscle (between 12th & 13th rib)

Skeletal Maturity

- Sacral Vertebrae
- Lumbar Vertebrae
- Thoracic Vertebrae
- Rib bones
- Chine Bones

- Skeletal ossification occurs from the posterior end (rear) to the anterior end (head) of the carcass

CARCASS MATURITY



Factors Potentially Influencing Physiological Maturity

- Gender
- Sex condition
- Breed type
- Implant program
- Diet

Skeletal Maturity

Physiological maturity determined by evaluating the size, shape and ossification of the bones and cartilages, the color & texture of the lean of the ribeye.

All maturity indicating factors are considered – composite evaluation

Factors seldom develop to the same degree – limitless number of potential combinations to consider

Quality Grade Determination

- Sex Classification
- Maturity evaluation based on evidences of skeletal maturity and color and texture of ribeye muscle (between 12th & 13th rib). Only if over 30 months.
- Marbling and Firmness of Ribeye Muscle (between 12th & 13th rib)

Marbling

- Fat within the muscle
  - Intramuscular fat

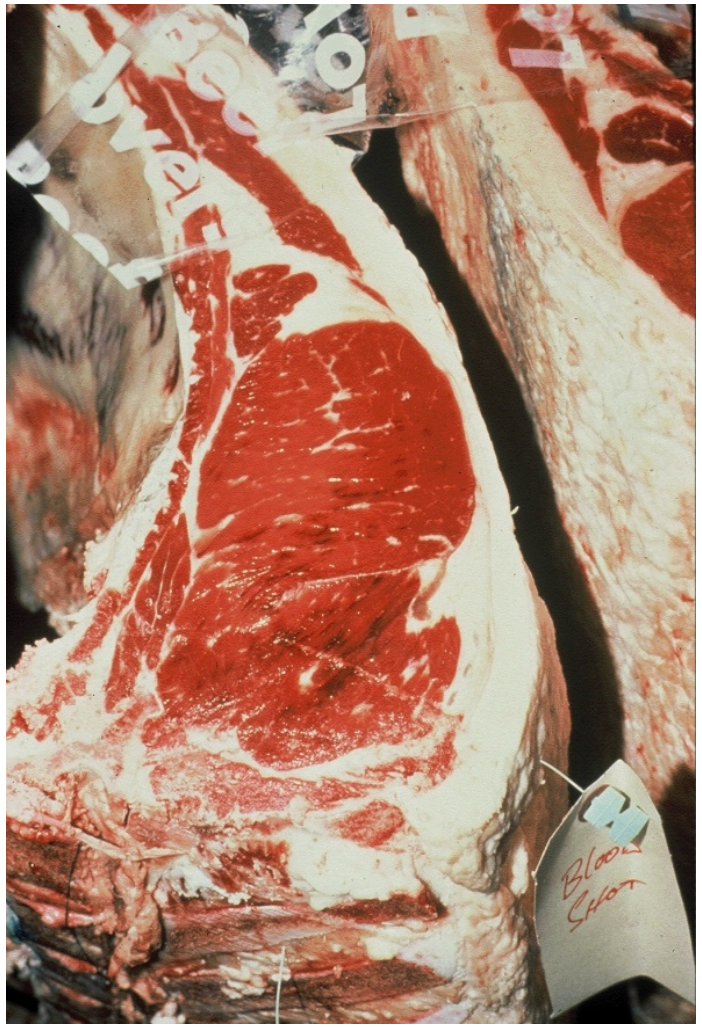
- Evaluated on the ribeye between the 12th & 13th ribs

Marbling

- Influences
  - Chill
  - Bloom
  - Lighting

Conditions or Defects Preventing or Lowering a Grade

- **<u>Blood Splash</u>**
  - When a carcass is not dressed and prepared properly at harvest, blood pressure within the carcass can spike and capillaries in the muscle tissue can rupture.
  - Carcasses can have a "small" amount of blood splash & still grade. The "small" amount is based on the "Slight" marbling card.

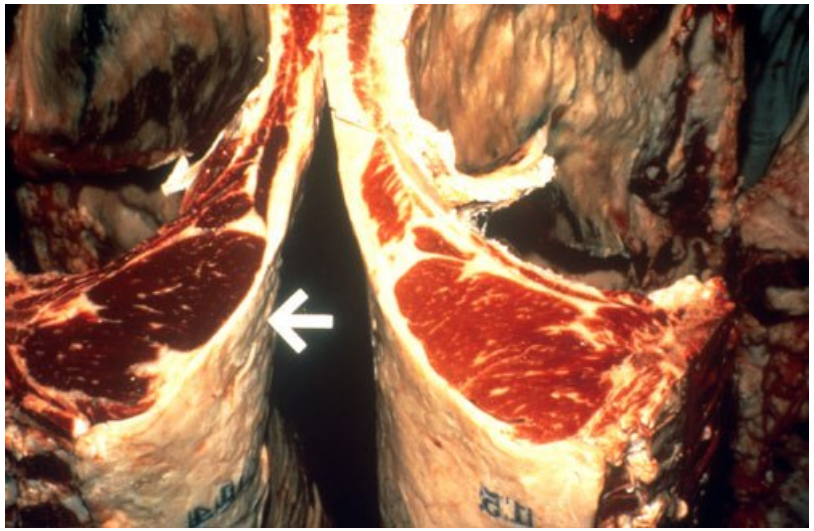


Conditions or Defects Preventing or Lowering a Grade

- **<u>Calloused</u>**
  - Result of steatosis; fatty tissues spreads into areas of the muscle creating a callous section; strenuous muscle exertion.
  - The maximum amount of calloused to still grade is a small amount (less than ½ inch)

Conditions or Defects Preventing or Lowering a Grade

- **Dark Cutters**
  - Dark Cutting characteristics are determined in percentage, from 10 to 100%.
  - Dark Cutting beef affects overall quality grade
  - Each percentage dark relates to the discount amount you will assign to the carcass.
  - Up to 1% of beef carcasses are dark cutters



What is Dark Cutting Beef?

- Dark, firm, and dry is the name of the condition
  - Dark in color because of light absorption
  - Firm because muscle proteins are pulled together more tightly
  - Dry in appearance due to more water held in the muscle
- Caused by a variety of factors including:
  - Aggressive activity
  - Estrus
  - Stress – long term
  - Growth Promotants
  - Weather
- Most of the sugars in the muscle are used up by the live animal during stress
- Minimal sugars left for postmortem muscle metabolism

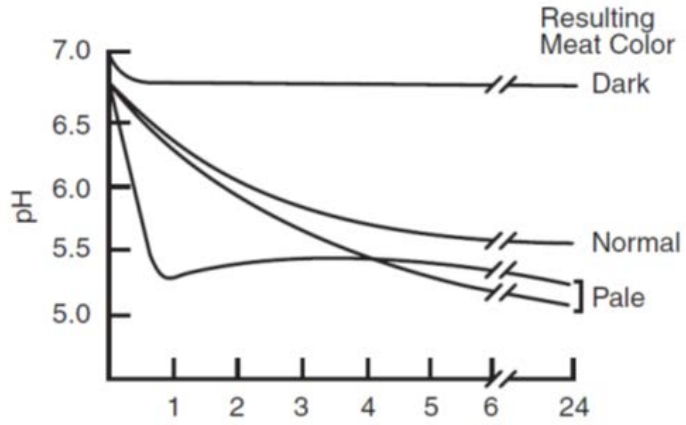


Figure Source: *Principles of Meat Science, 4th Edition*

USDA Yield Grade

Yield Grade Factors

- Thickness of fat over the ribeye (backfat)
- Ribeye area
- Hot Carcass Weight
- Percentage of kidney, pelvic, heart fat (KPH)

Yield Grade Factors

Thickness of fat over the ribeye (backfat)

Remember this is the second area where fat is deposited

Yield Grade Factors

Ribeye Area

This is a measurement of the muscle growth and mass

Yield Grade Factors

Hot Carcass Weight

This is where we relate how well a carcass is muscle in relation to its overall weight

Yield Grade Factors

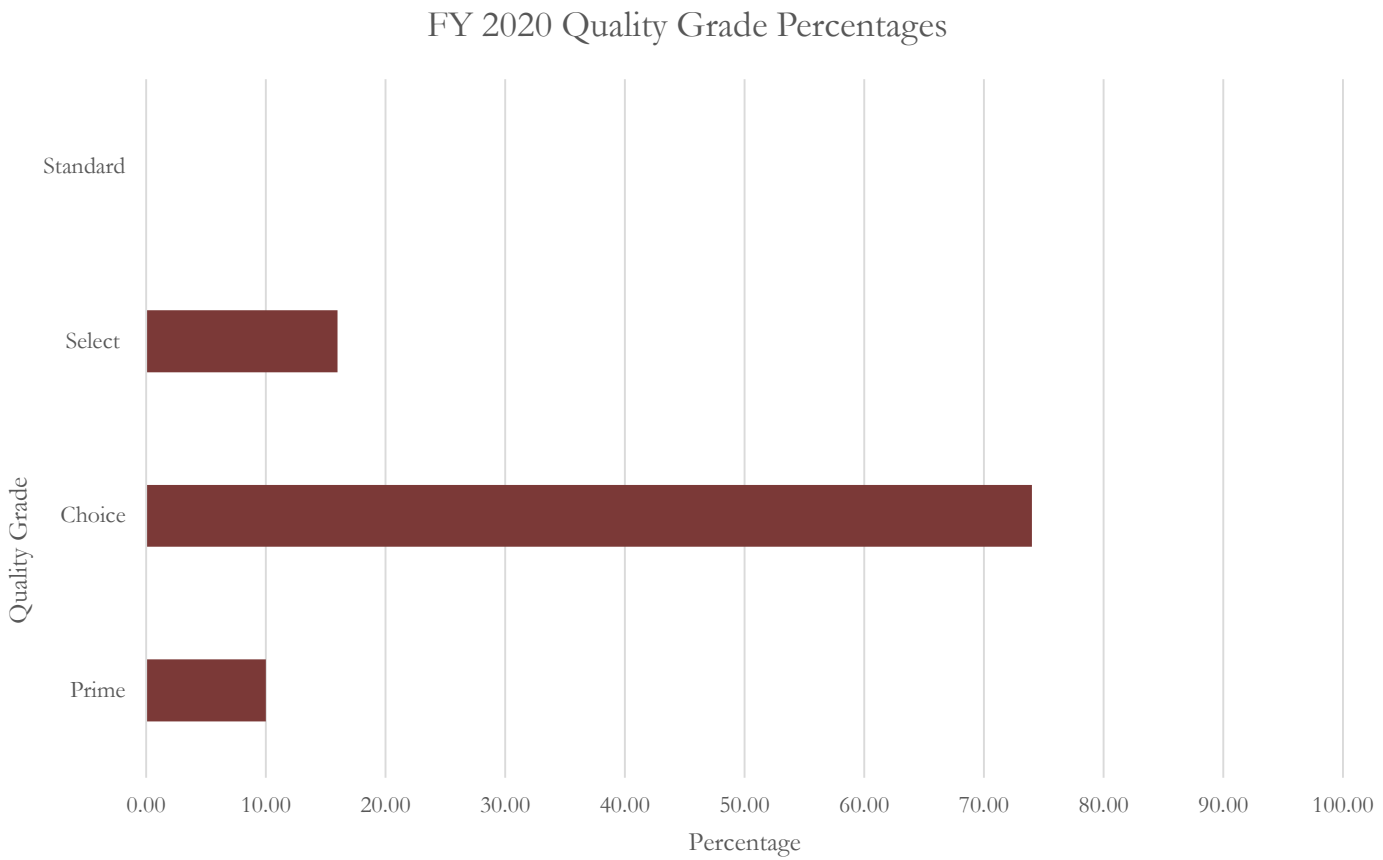
Percentage of kidney, pelvic, heart fat (KPH)

This is a measurement of the internal fat deposits, one of the first areas for fat development

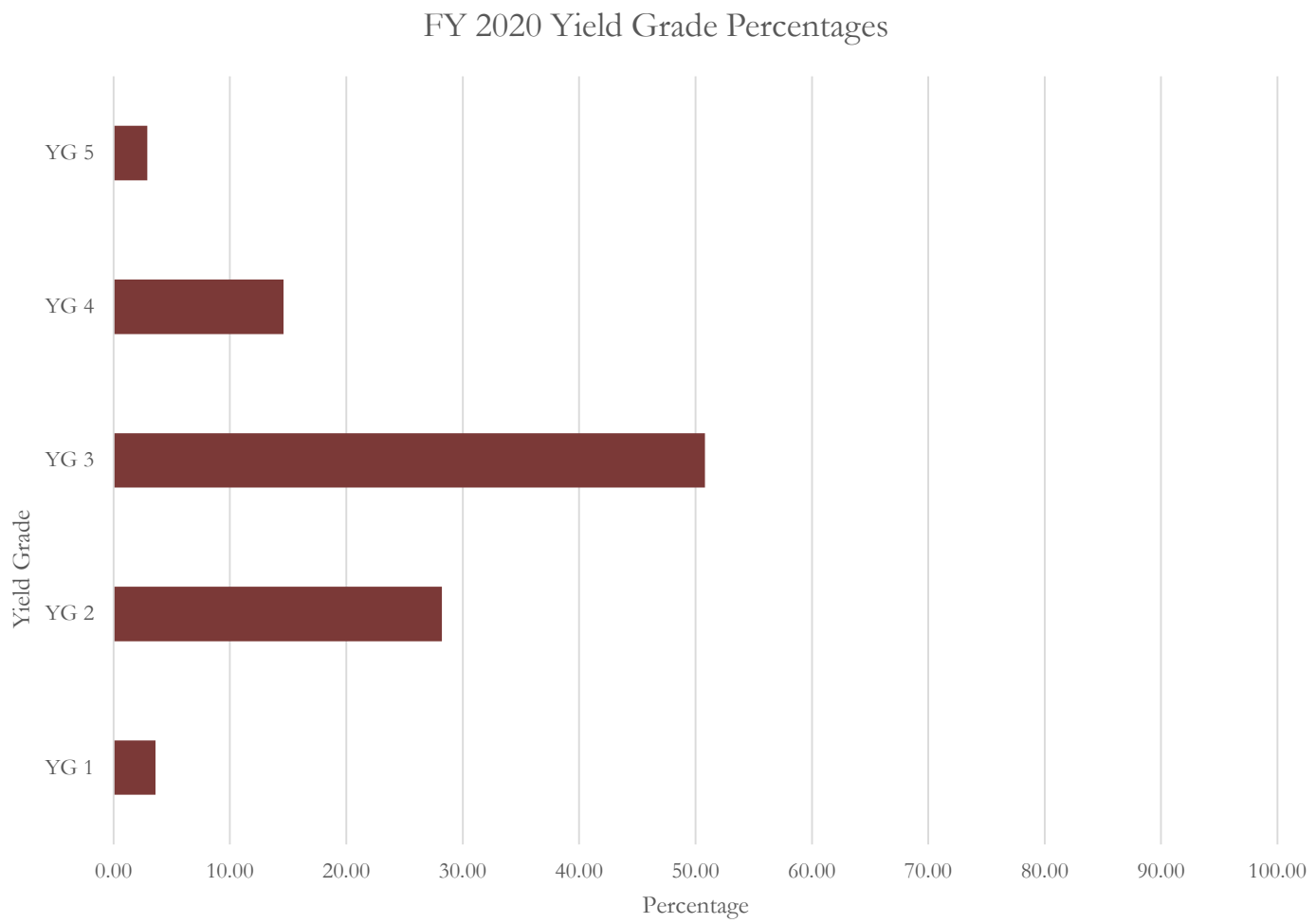
Percentages of Retail cuts for the various YG

Yield Grade	Percent Boneless, Closely Trimmed Retail Cuts from the Round, Loin, Rib & Chuck	
1.0	> 52.3%	
2.0	52.3-55.0%	
3.0	50.0-47.7%	
4.0	47.7-45.4%	
5.0	<45.4%	

FY2020 Beef Grading Summary



FY2020 Beef Grading Summary



USDA United States Department of Agriculture

Thank you for Participating

For more information on this webinar series and the

USDA Cattle and Carcass Training Centers, visit:

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