Exploring factors that contribute to beef tenderness

Tracy Scheffler

Department of Animal Sciences

Meat A product of life and death

Tenderness

Juiciness

Color

Texture

Marbling

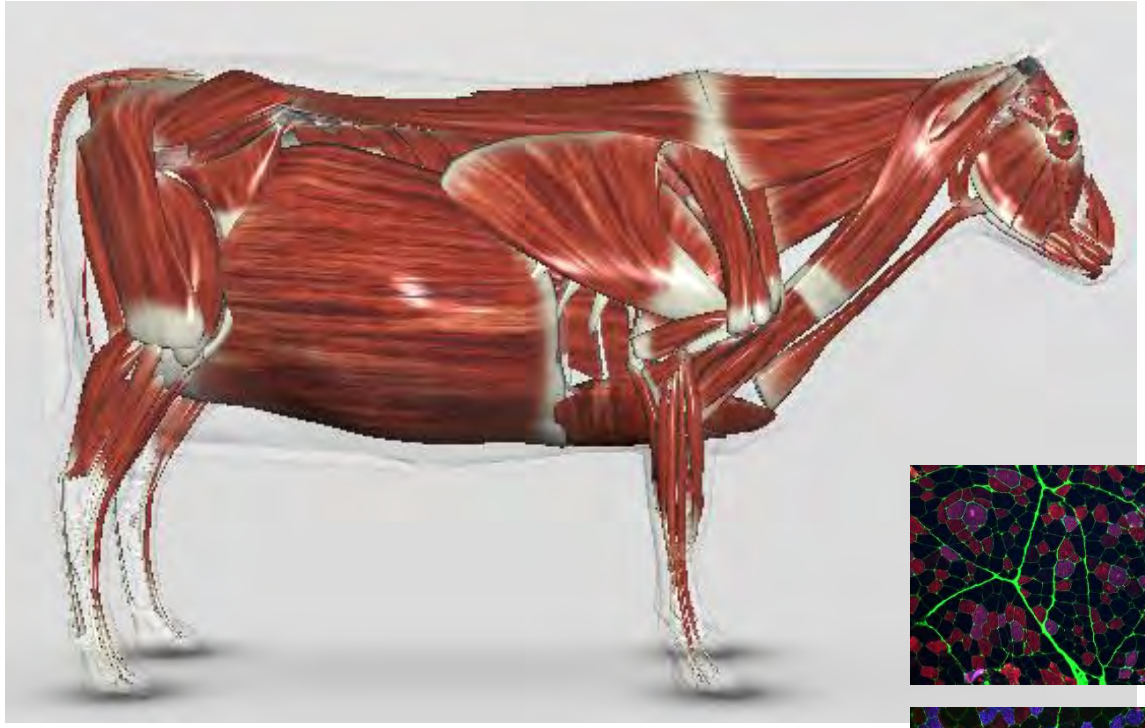
Flavor

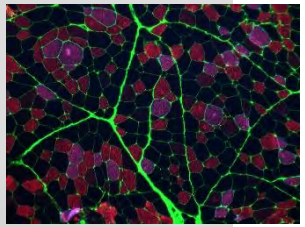
Tenderness – key factors

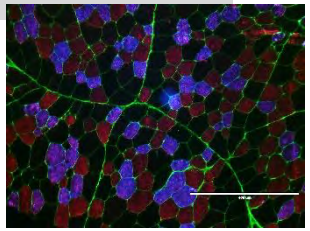
- **Postmortem protein degradation**
- Connective tissue
- Marbling

Muscle – built for life

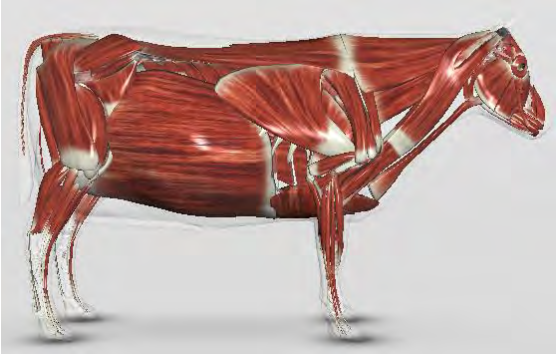
- A machine
- Shapes & sizes
- Build, maintain, & repair
- Adapt







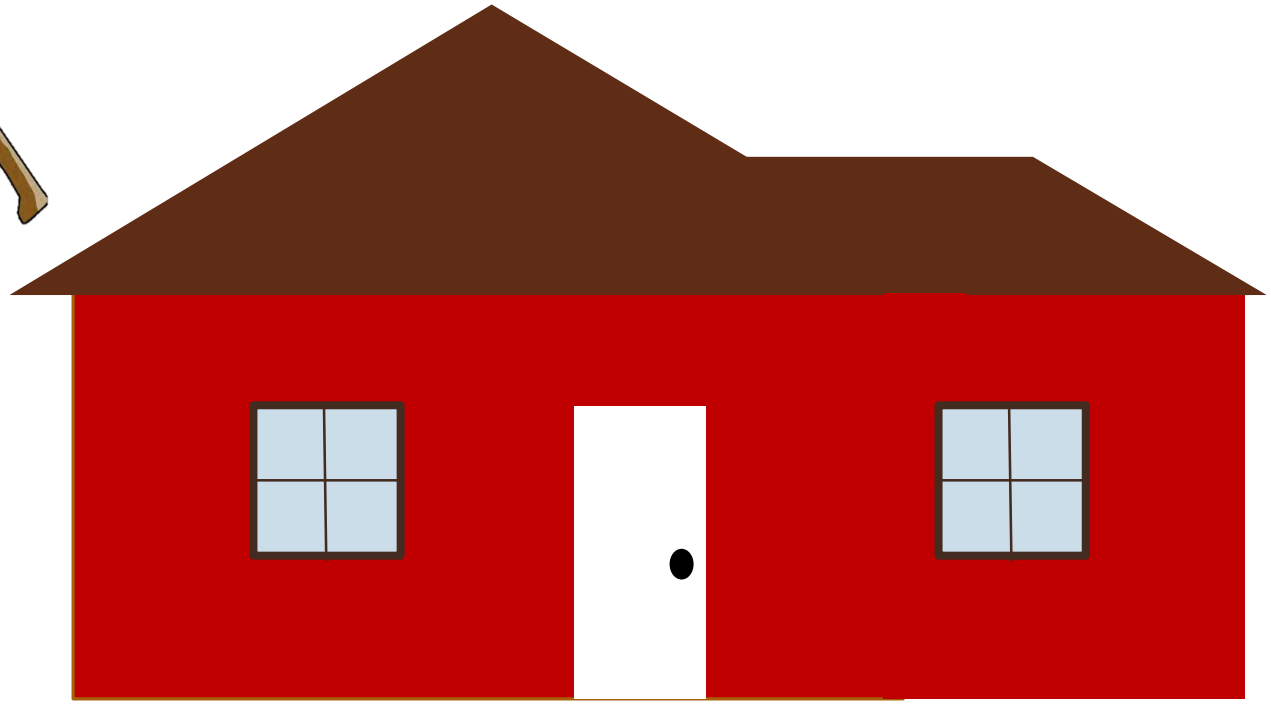
	Living muscle	Dying muscle/meat
System		
pH		
Temp.		
Energy		



Living muscle - growth and maintenance

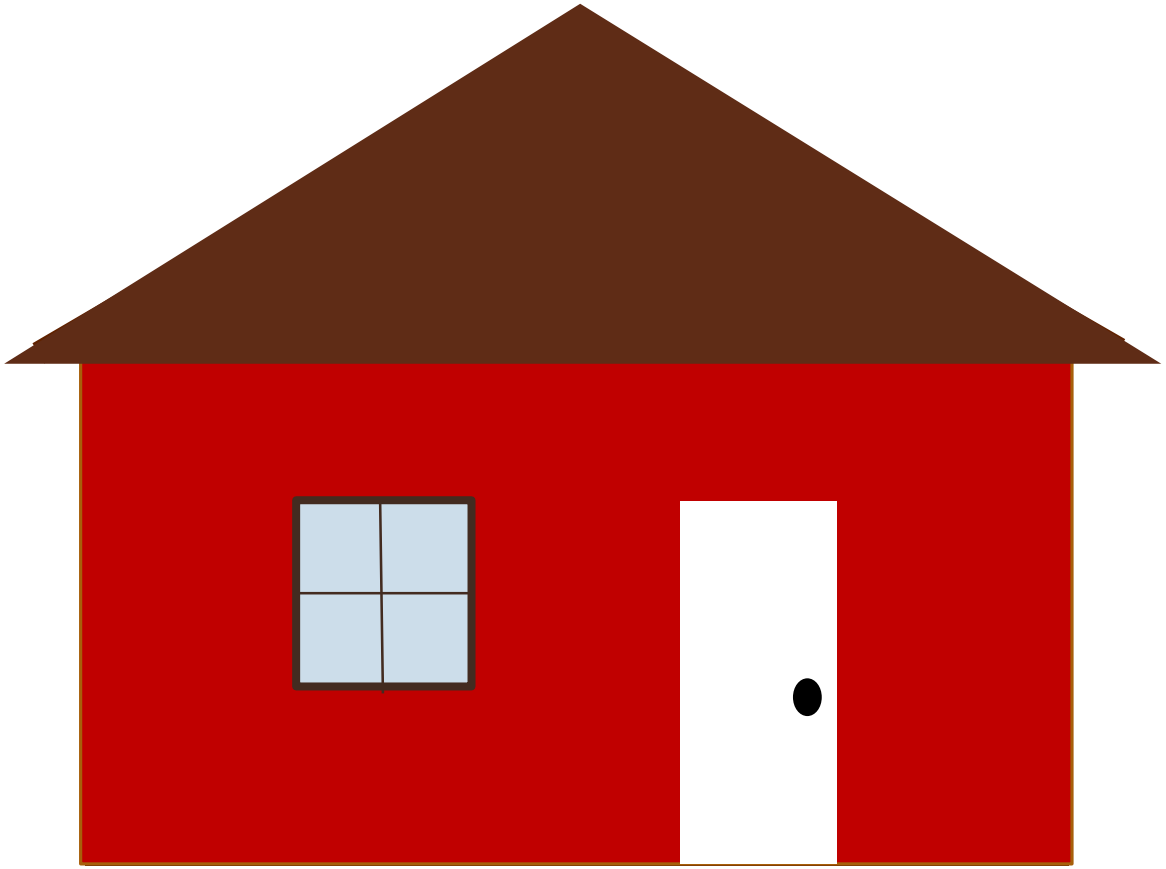
Synthesis and degradation of muscle proteins

- Different tools
- Energetically demanding



Protein degradation in muscle after death

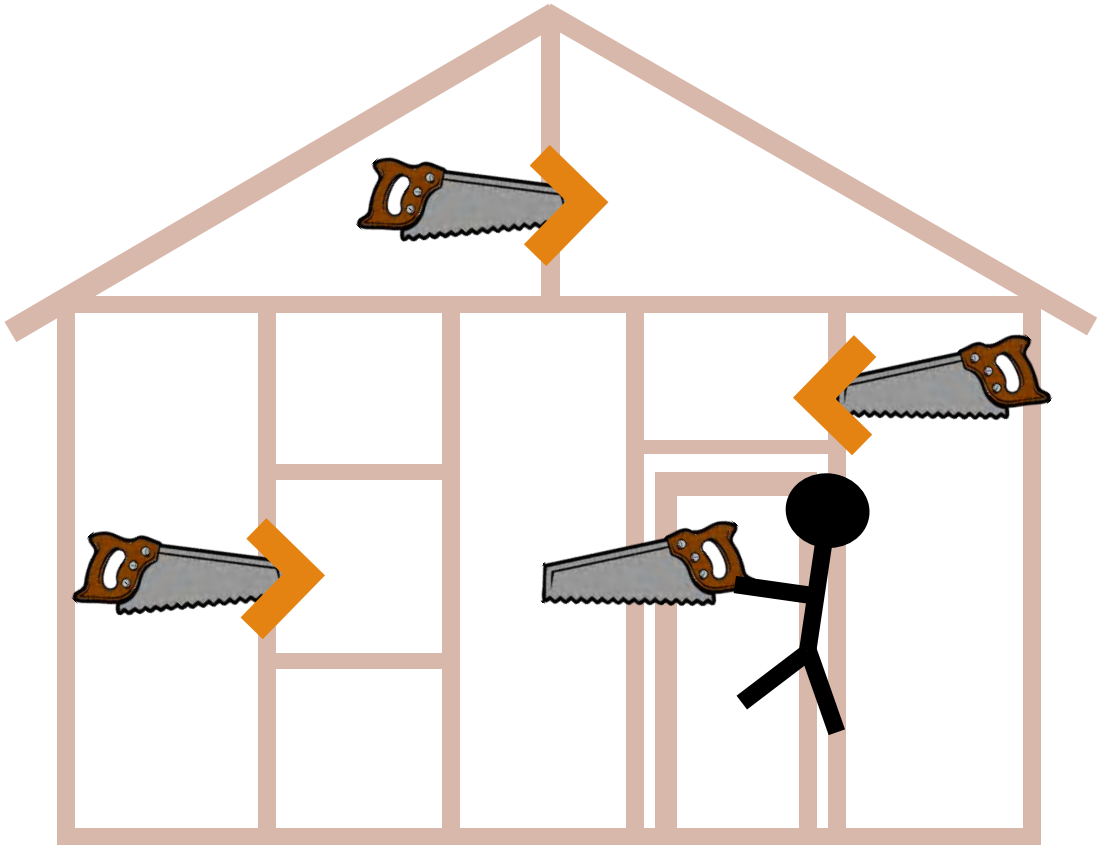
- One tool – calpain
- Contributes to tenderness



Protein degradation – muscle & meat

Calpain activity is regulated

- Calcium dependent
- Calpastatin – inhibitor



- Postmortem events

How do we evaluate postmortem protein degradation?

- Calpain 
- Calpastatin
- Calpain : calpastatin
- Breakdown of individual proteins

Protein degradation explains some variation in tenderness

- Muscle
- Breed/type

"No neck hump exceeding 2 inches (safeguards against cattle with more variability in tenderness)"

Program/Brand Name	Certified Angus Beef
Schedule number	G-1
Live Animal Requirement	
Phenotype	GLA
Genotype	GLA[v]
Other	
Carcass Characteristics	
U.S. Prime	X
U.S. Choice	X
U.S. Select	
U.S. Standard	
U.S. Utility and Commercial	
Maturity	A
arbling score requirement	MT[00] or higher
Medium or fine marbling texture	X
Yield grade	
Ribeye area (square inches)	10.0 - 16.0
Hot carcass weight (pounds)	< 1050*
Fat thickness (inches)	< 1.0
Minimum muscling requirement	X
Carcass class (type)[v]	S & H
Capillary rupture in ribeye muscle[2]	PF
Free of dark cutting characteristics	X
Max hump height (≤ 2 inches)	X

Understanding tenderness in *Bos taurus* and *Bos indicus*

Breed Group	Fraction*	Angus	Brahman
1	Angus	0.80-1.00	0.00-0.20
2		0.60-0.79	0.21-0.40
3	Brangus	0.625	0.375
4		0.40-0.59	0.41-0.60
5		0.20-0.39	0.61-0.80
6	Brahman	0.00-0.19	0.81-1.00

*Cattle represent a continuous spectrum of Angus-Brahman genetic variation

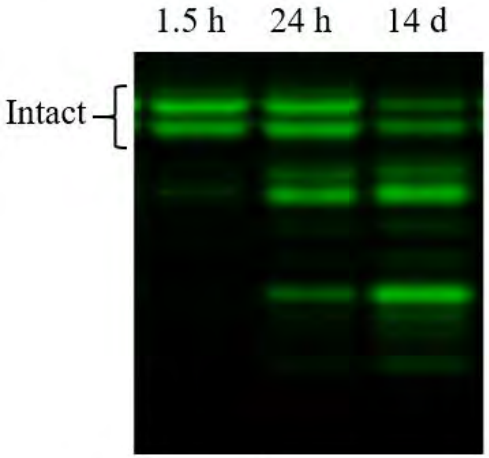
Objective tenderness

Tough

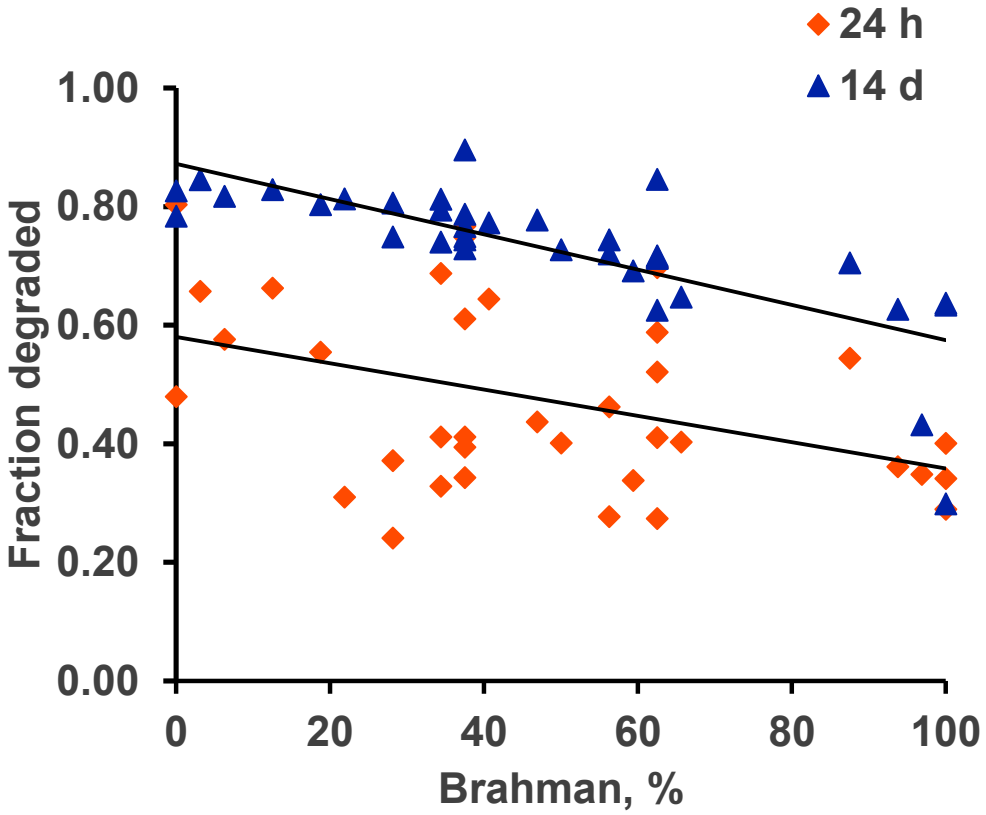
Tender

Elzo et al., 2012
Wright et al., submitted

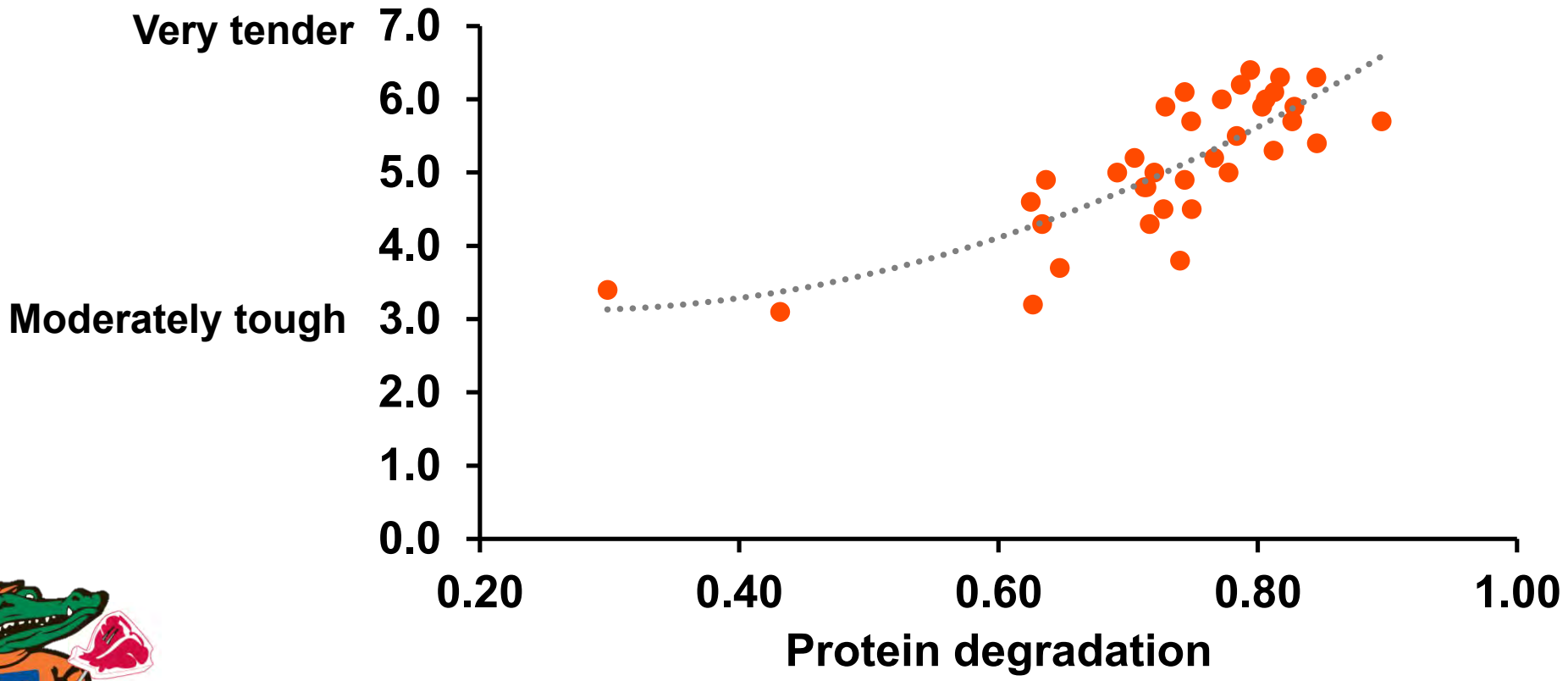
Protein degradation



Angus

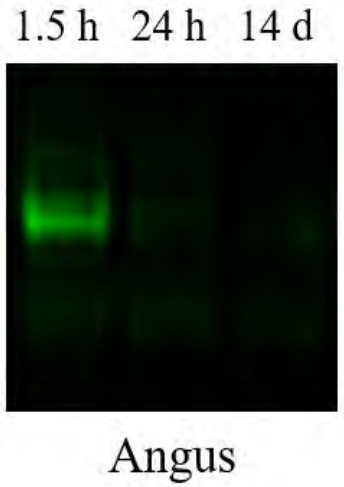


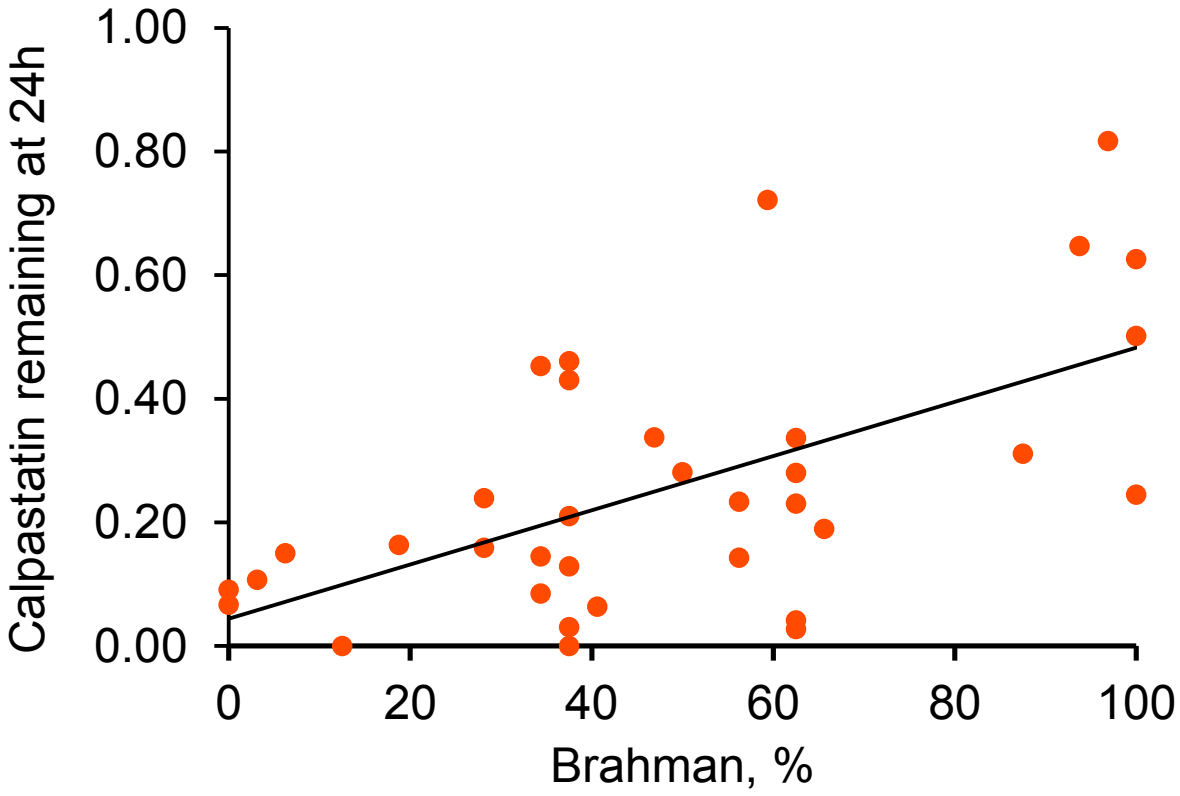
Protein degradation & tenderness



Calpastatin

Degraded during postmortem period, aging

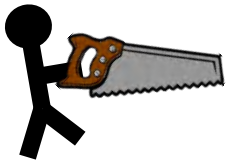




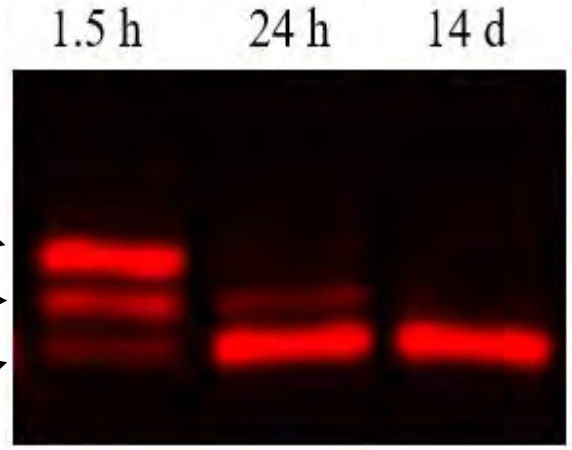
The Calpain System

Inactive

Intermediate



‘Activated’



Angus

Increasing Brahman composition

- On average, decreases tenderness
- ↓ calpain activation
- ↑ intact calpastatin

How can we increase protein degradation & improve tenderness?

Will this affect muscle growth or other traits?

Increasing calpastatin in muscle

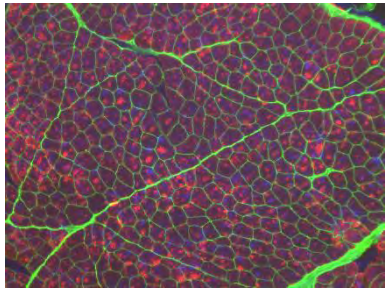
- Growth & remodeling?
- Metabolism?
- Heat tolerance?

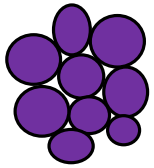
Muscle fiber characteristics

- Contraction

Endurance

Type 1

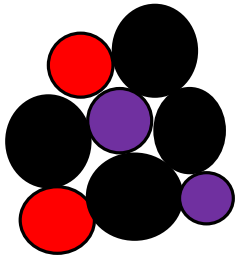


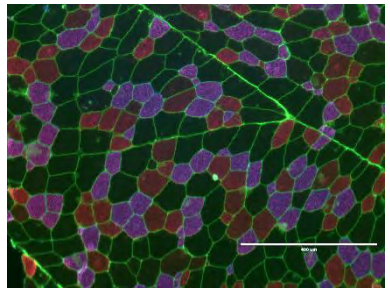


Strength / power

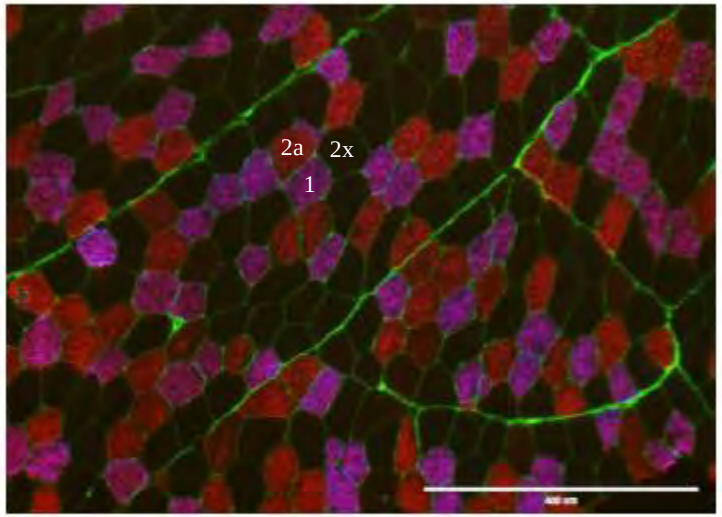
Type 2a

Type 2x

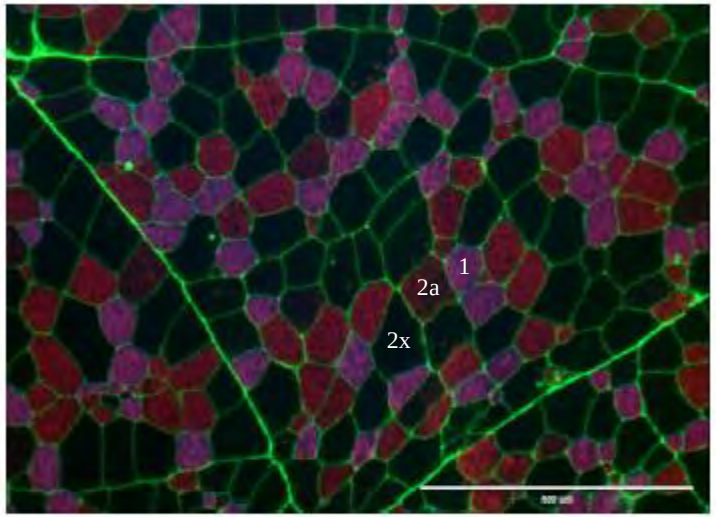




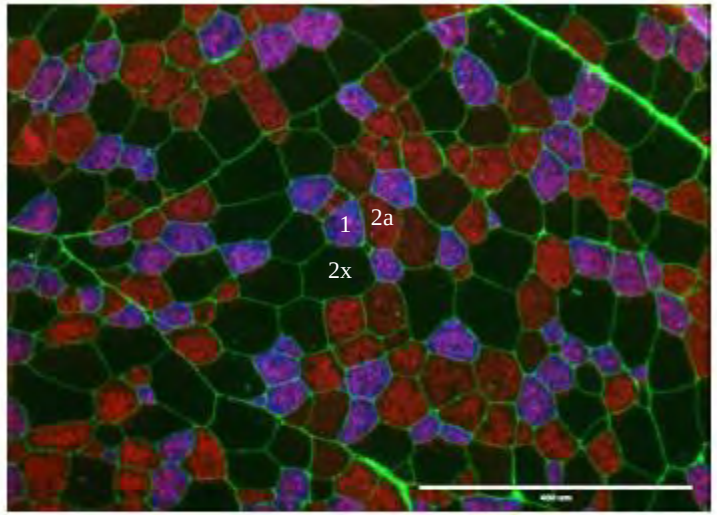
Determining contractile fiber type



Angus



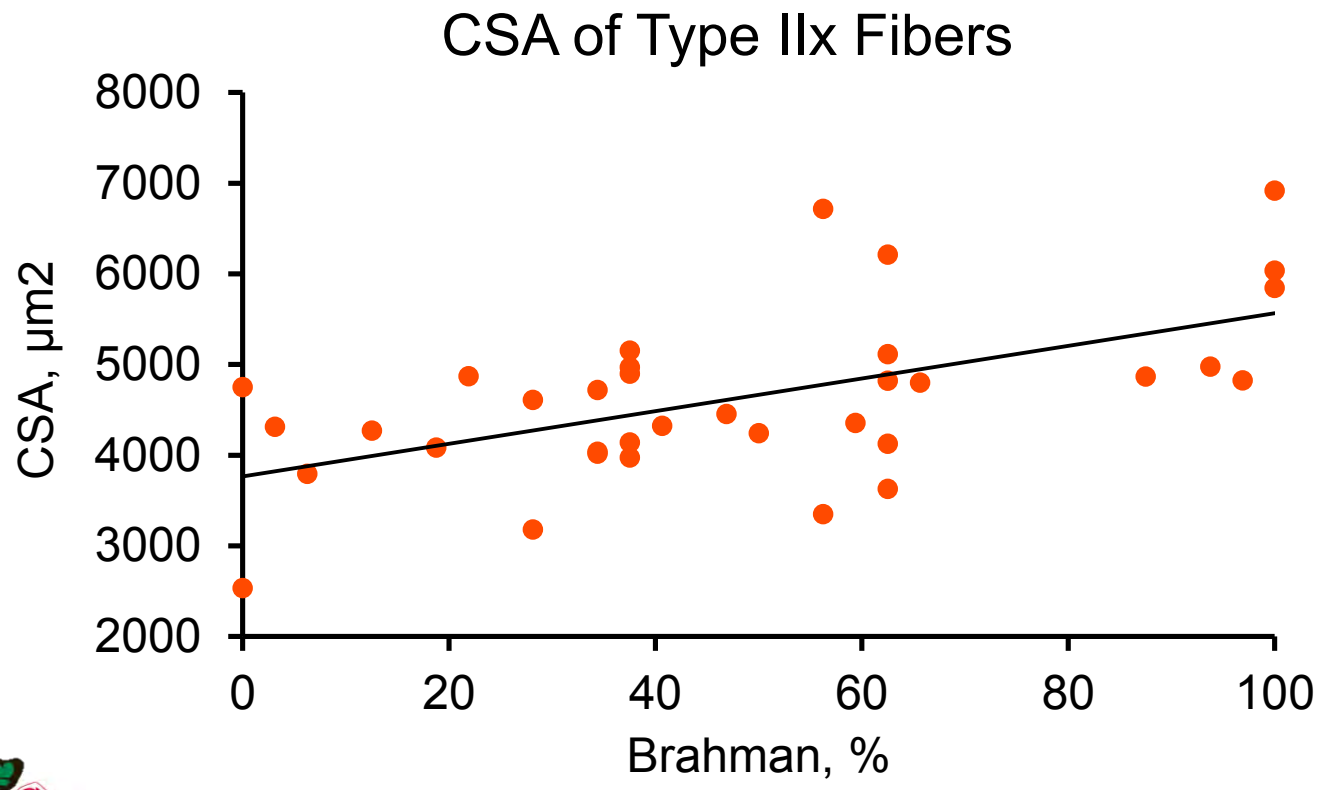
Brangus

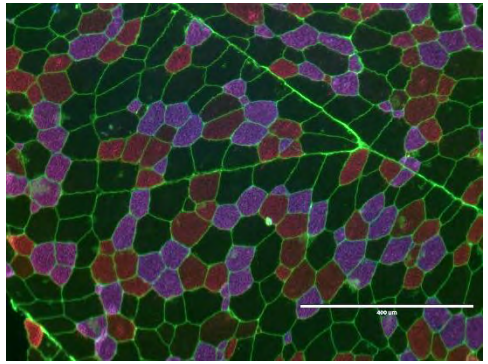


Brahman

Type 1
Type 2a
Type 2x

Muscle fiber cross-sectional area (CSA)





Is calpastatin higher in certain fibers?

Muscle fiber characteristics

- Contraction
- **Metabolism**

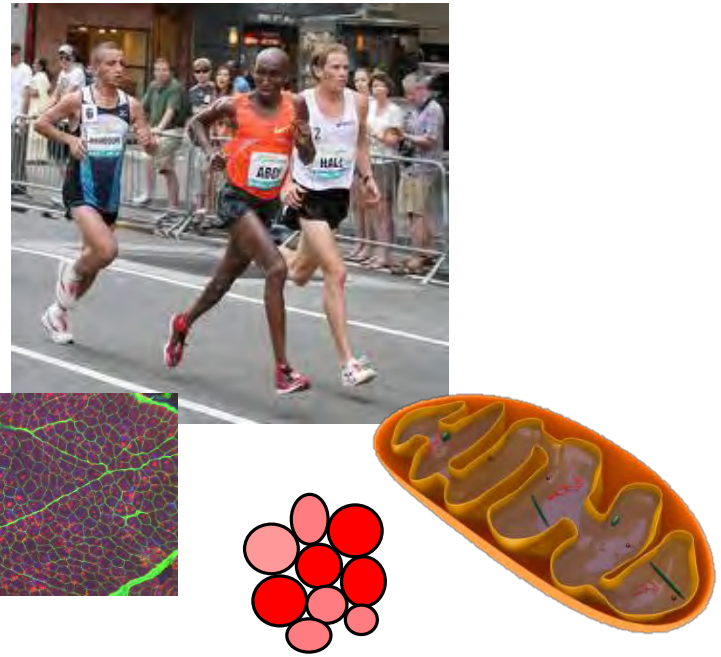
How the cell produces energy

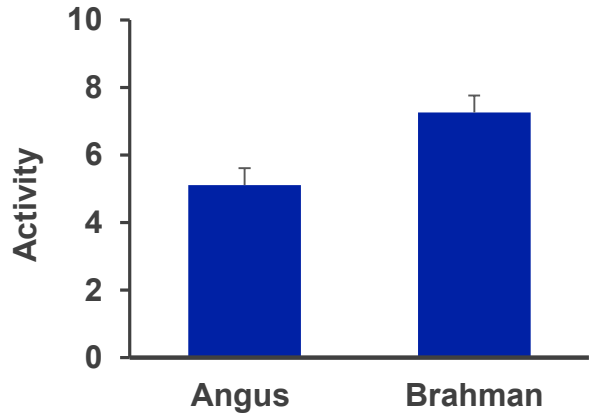
Endurance
Type 1

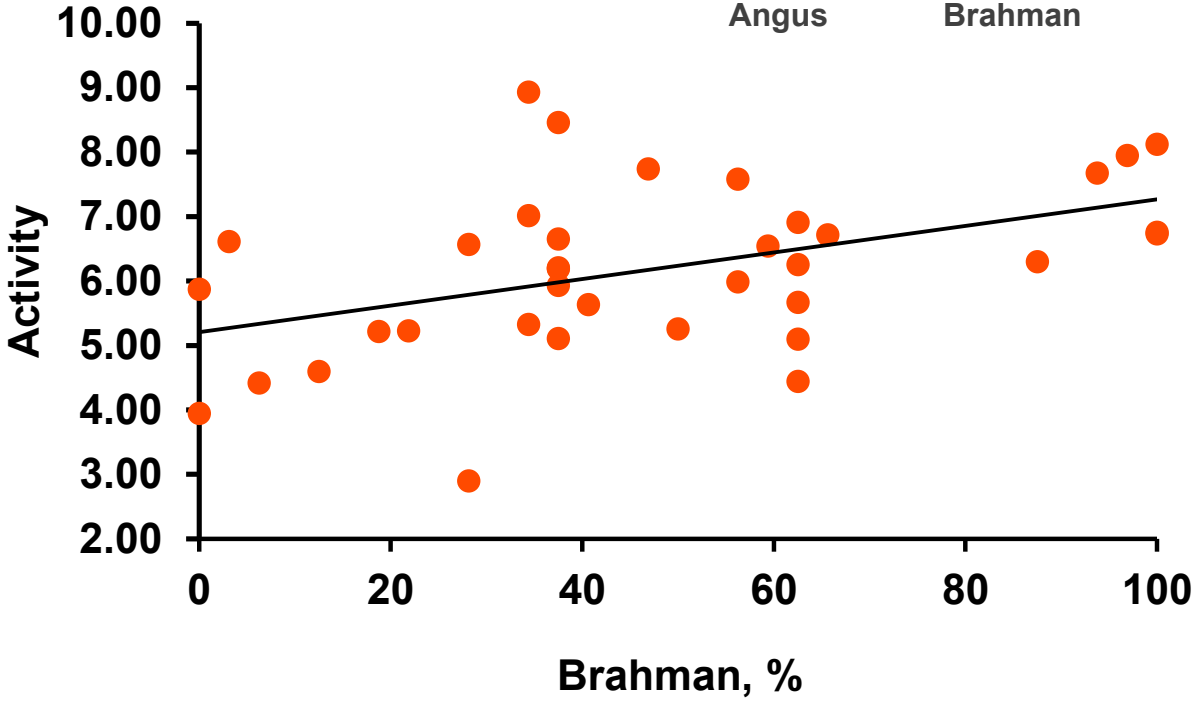
Strength / power
Type 2a
Type 2x

Oxidative **Glycolytic**

Oxidative enzyme activity

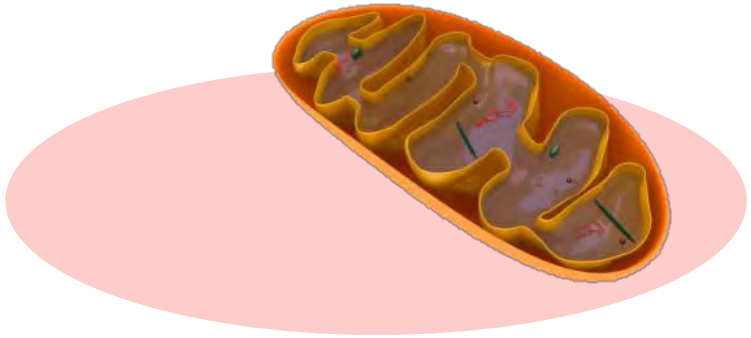






Shifting muscle metabolic properties

Mitochondria



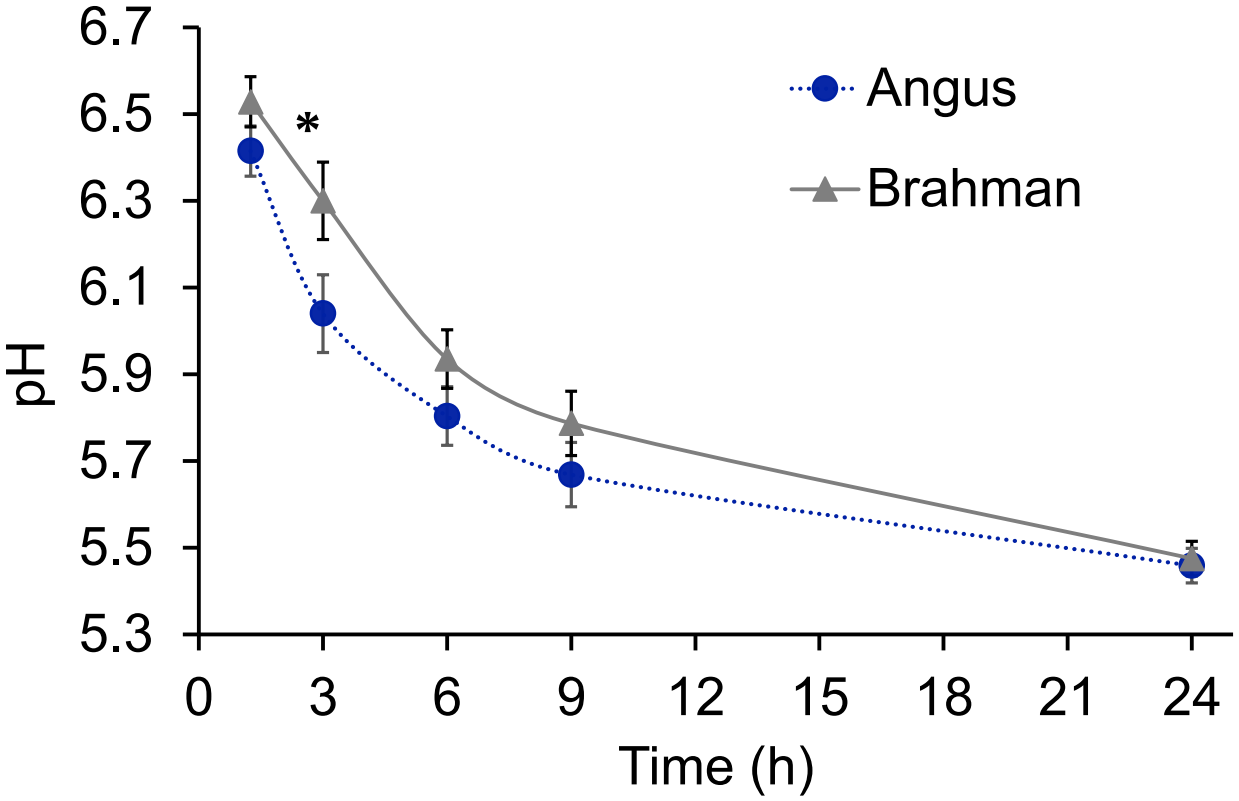
- Energy production
- Efficiency
- Calcium regulation
- Trigger cell death

Endurance

Strength

Postmortem changes in pH

- Related to energy depletion
- Delay calpain activity?



Shifting muscle metabolic properties

What else might be different?

Endurance

Strength / power

Oxidative

Glycolytic

Development of tenderness

- Complex trait
- Muscle properties
- Postmortem events

- Regulation
- Relationship to other important muscle & animal traits

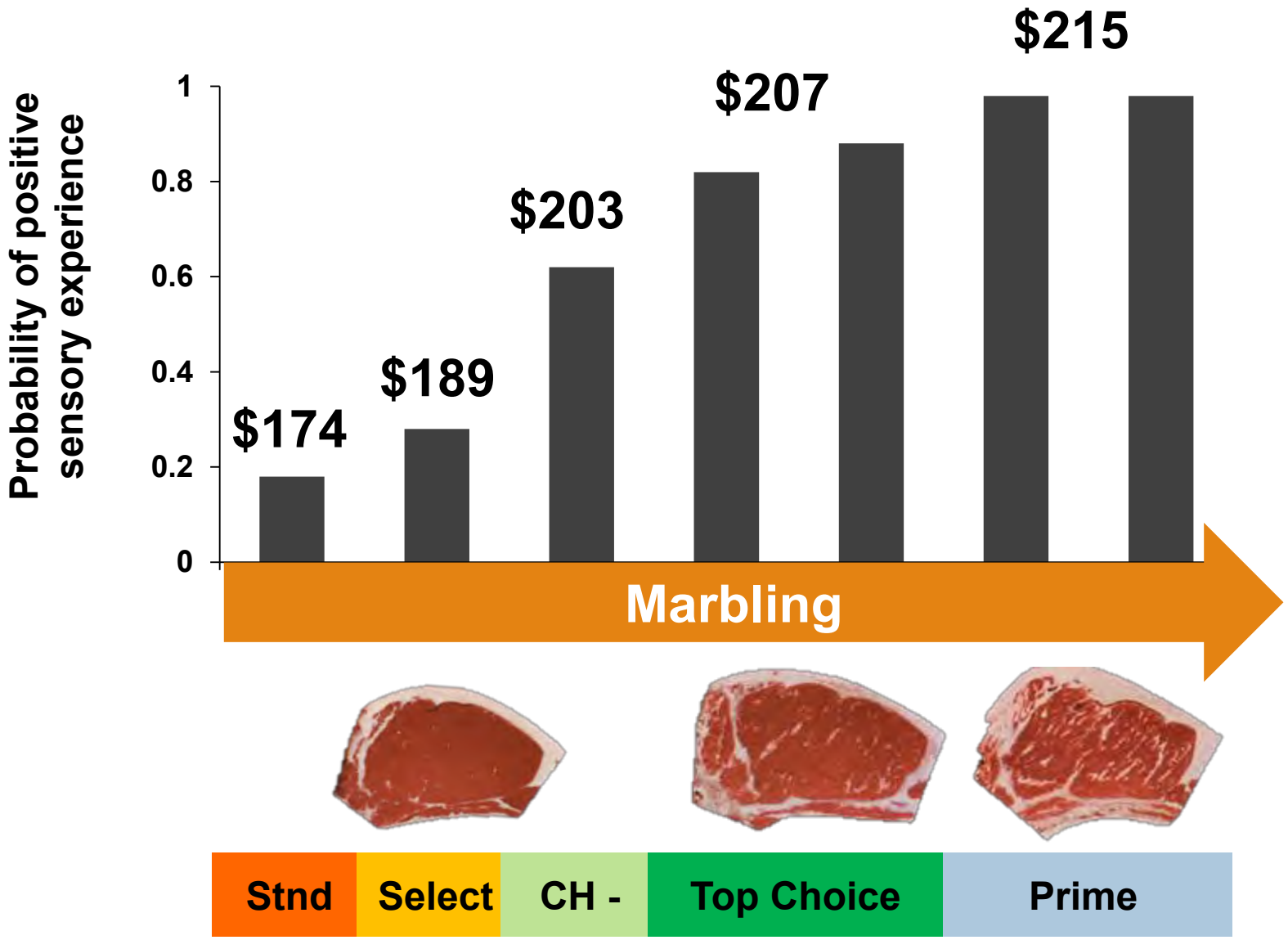
Acknowledgements

Thanks to

- Dr. Chad Carr
- Dr. Dwain Johnson
- Dr. Mauricio Elzo
- Dr. Jason Scheffler
- Dr. Raluca Mateescu
- Dr. Steffi Wohlgemuth
- Shelby Wright
- Patricia Ramos
- Amy Bass
- Charlotte Mason
- Kyle Mendes
- UF Meat Lab

- Florida Cattlemen's Association
- UF IFAS

Effect of marbling on probability of a positive rating



Emerson et al., 2012

Bos indicus and tenderness

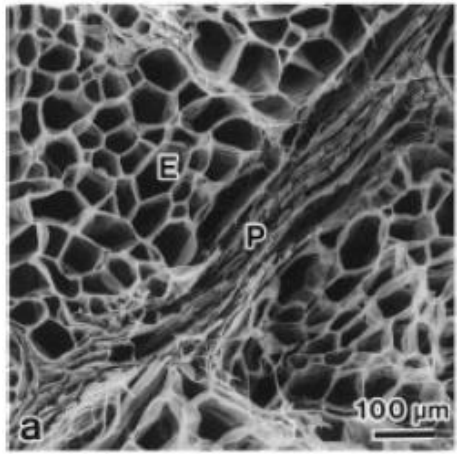
- **"No neck hump exceeding 2 inches** (safeguards against cattle with more variability in tenderness)"
- 80 / 85 programs

USDA Certified Beef Programs

Company	Demkota Ranch Beef		Elkhorn Valley Packing			FM Meats Products
Program/Brand Name	Demkota Ranch Beef	Double J Angus Beef	Premier Angus Beef	Valley Pride Black Angus Beef	EVP Angus Beef	FM Meats Angus
Schedule number	**G-21**	**G-88**	**G-50**	**G-66**	**G-93**	**G-38**
Live Animal Requirement						
Phenotype		GLA	GLA	GLA	GLA	GLA
Genotype		GLA*				
Other						
Carcass Characteristics						
U.S. Prime	X	X	X			X
U.S. Choice	X	X	X			X
Minimum muscling requirement		X	X	X	X	X
Carcass class (type)[1]	S&H	S&H	S & H	S, H & C	S & H	S & H & Cow
Capillary rupture in ribeye muscle[2]	PF	PF	PF	PF	PF	PF
Free of dark cutting characteristics	X	X	X	X	X	X
Max hump height (≤ 2 inches)	X	X	X	X	X	
USDA Information						

Tenderness – key factors

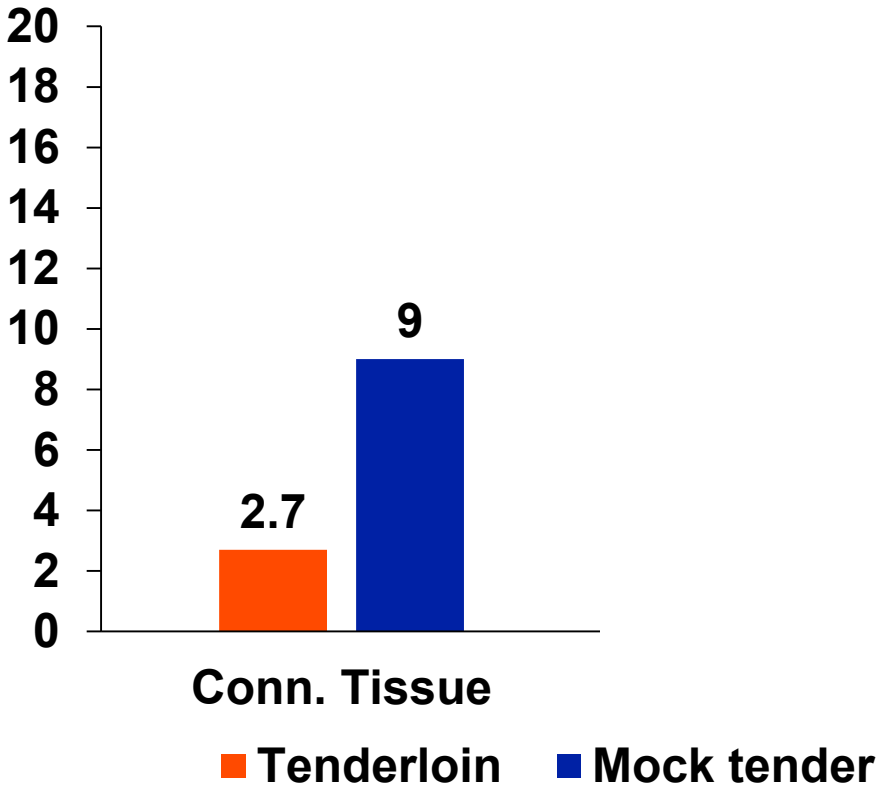
- Connective tissue



Tenderness – key factors

- Connective tissue – cut location

Tenderloin vs. Mock tender



Tenderness – key factors

- Connective tissue – old vs young animals
  - “hardbone”

Tenderness – key factors

- Connective tissue
- **Marbling**

Tenderness – key factors

- Connective tissue
- Marbling
- **Postmortem protein degradation**

Living muscle → Meat

- pH 7.2 → 5.6
- Temperature 101°F → < 40°F

- An ‘open’ system → closed system
  - Oxygen delivery eliminated
  - Waste ~~removal~~ accumulates