Heat tolerance and tenderness

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Brahman

On the pasture

- Heat tolerant
- Parasite resistance
- Lower maintenance requirements

On the plate

- Variation in tenderness
- Lower marbling

Angus Brahman

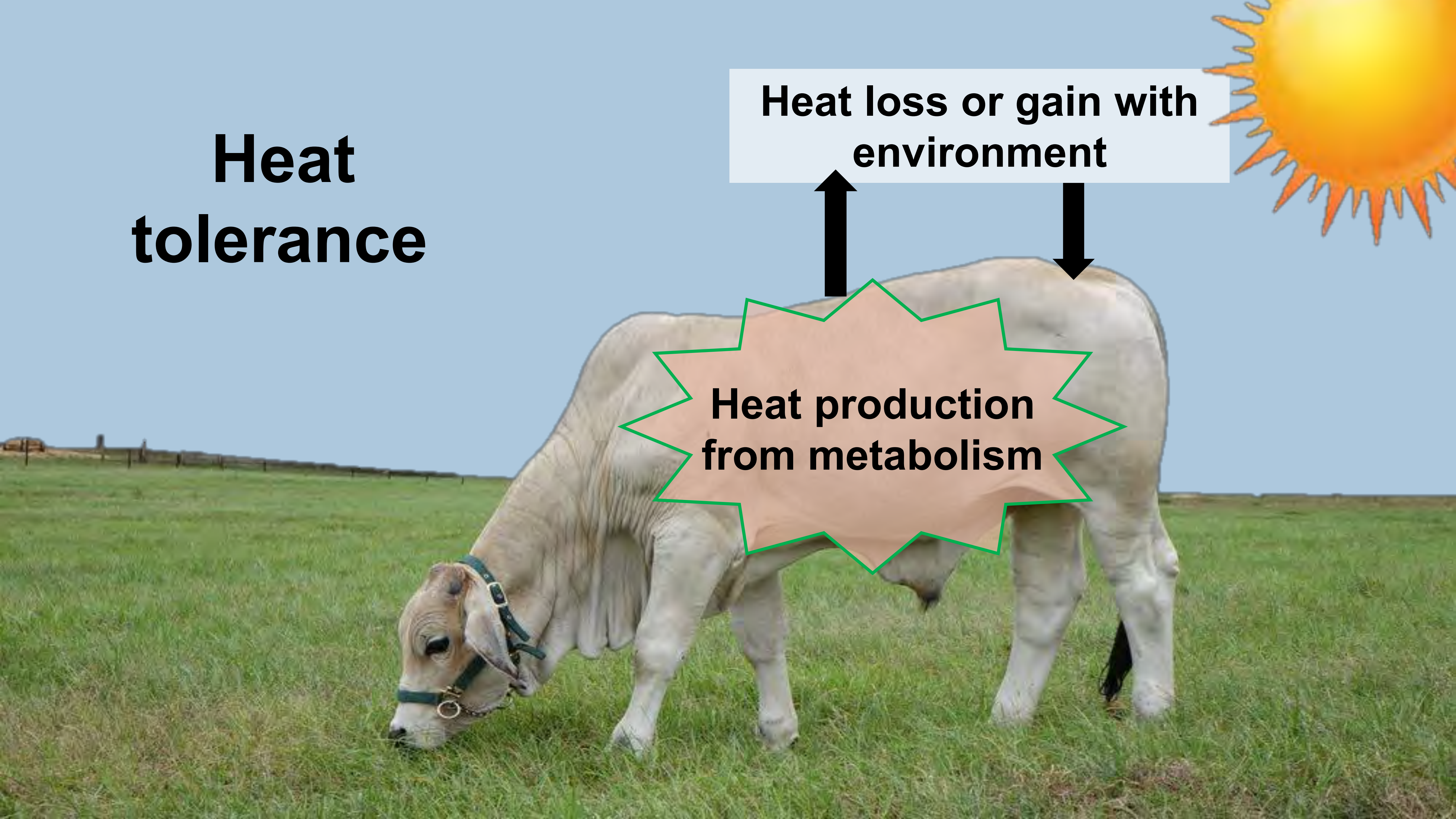
Key questions:

- **What features and adaptations make Brahman heat tolerant?**
  - ➢ **Brahman are resilient**

- **Is heat tolerance related to meat quality?**
  - ➢ **Meat – a product of life and death**

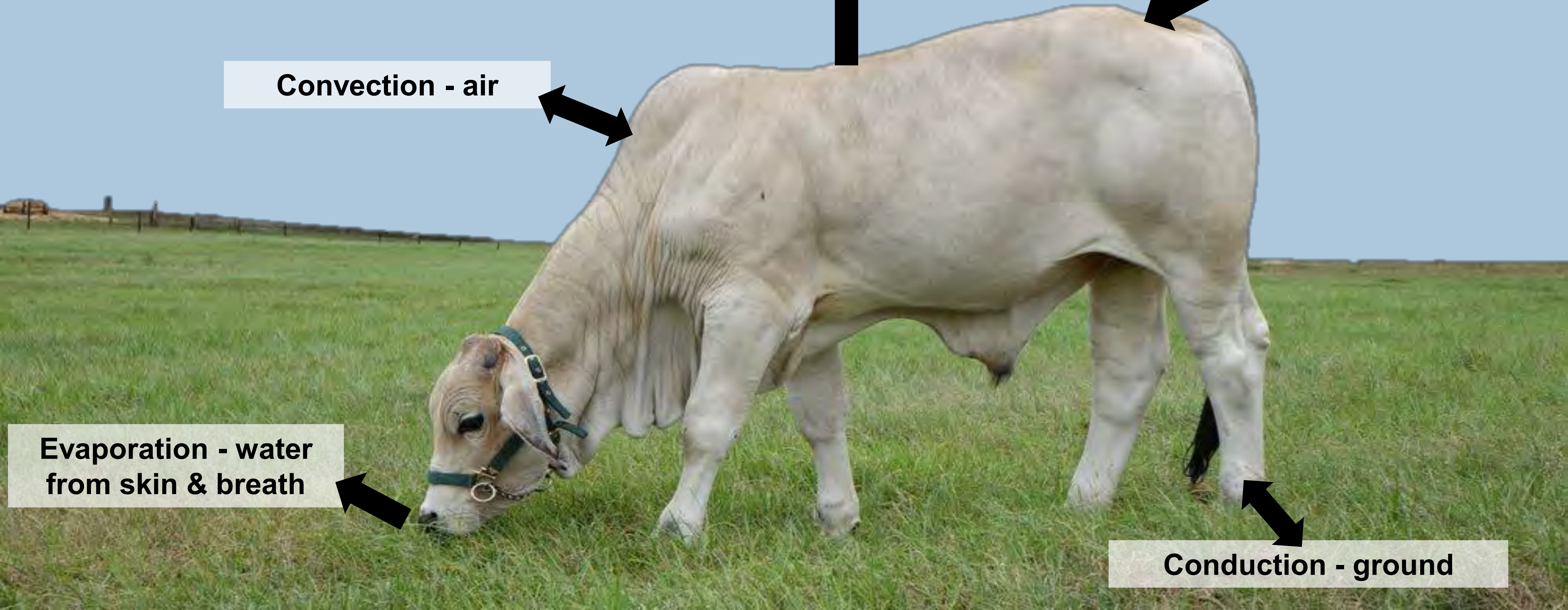
Angus

Brahman

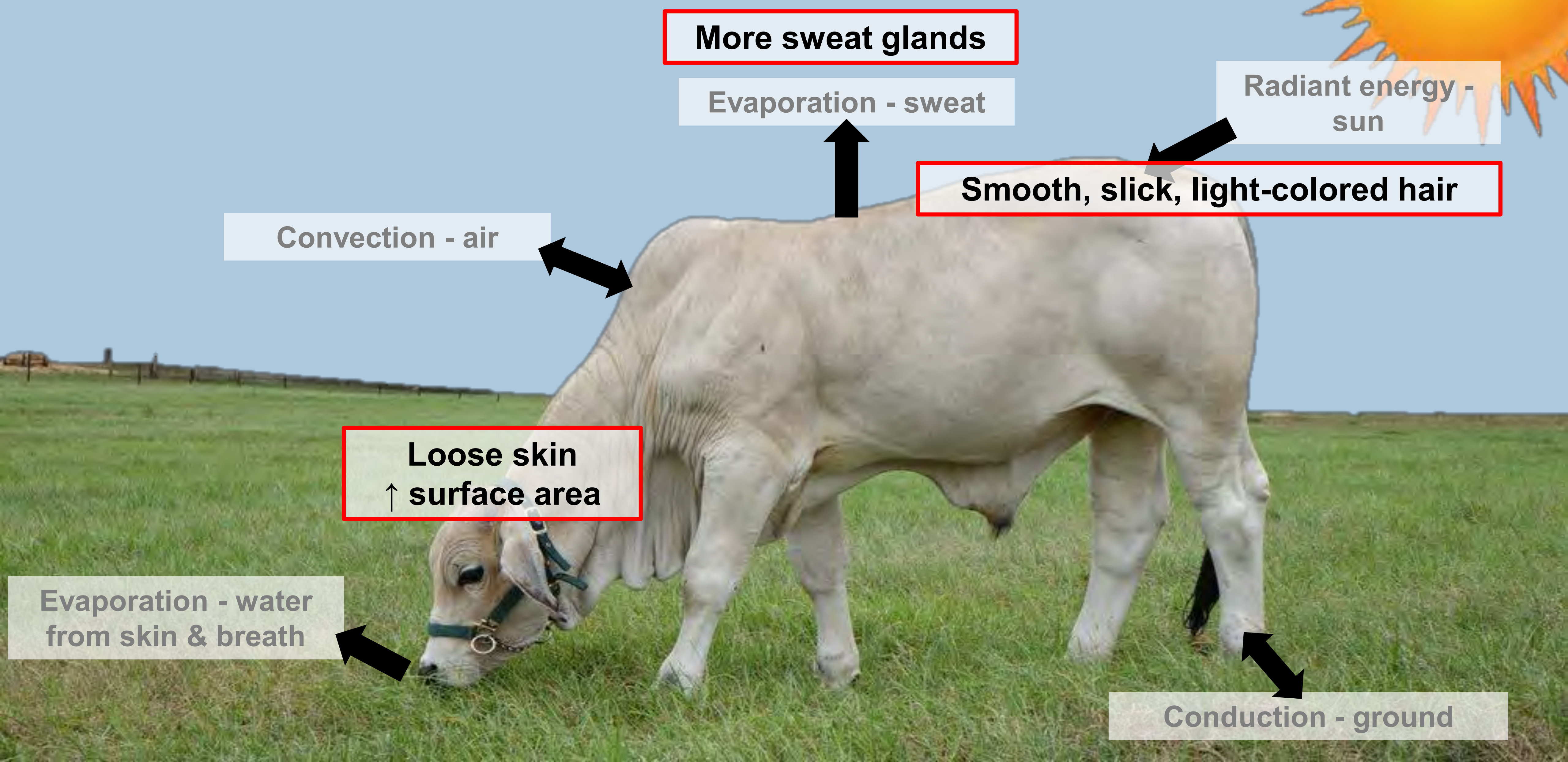

Heat tolerance
Heat loss or gain with environment
Heat production from metabolism

Heat exchange between the animal and the environment

- Animal surface area : weight
- Temperature gradient, animal vs. air
- Hair coat

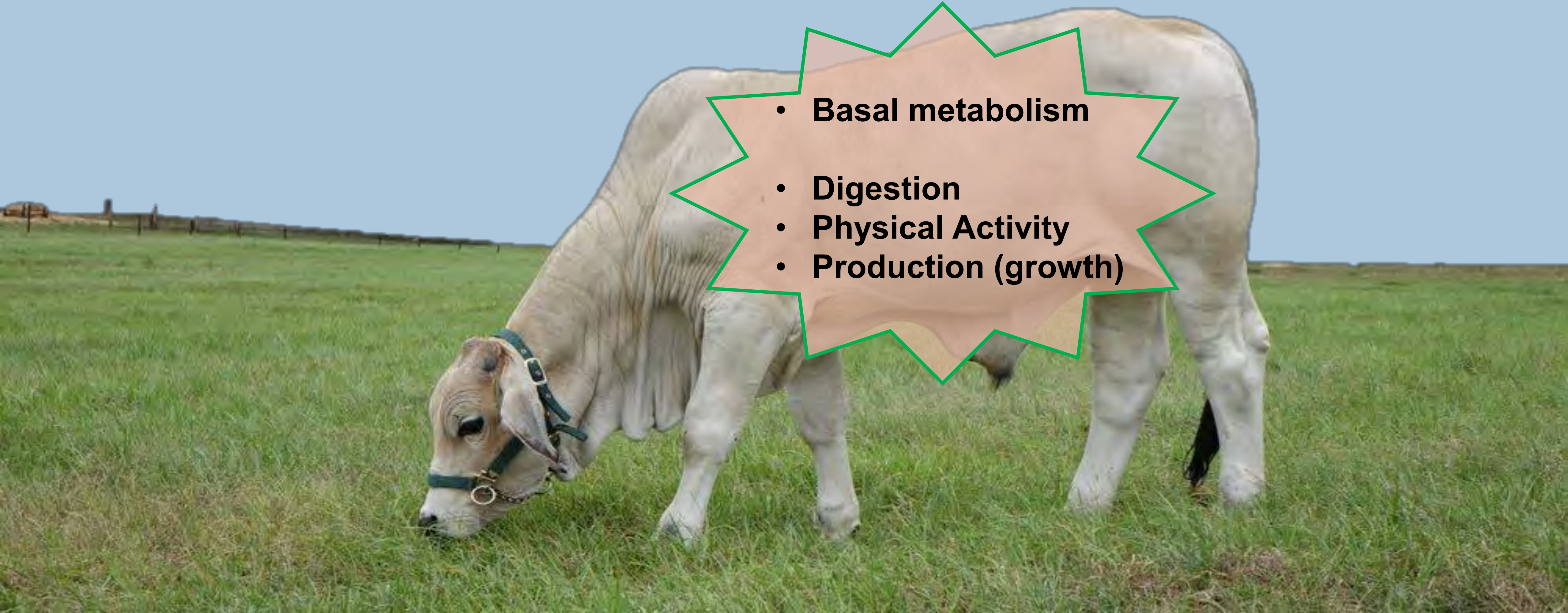


Heat loss in Brahman



Heat production (metabolic rate)

- Whole body
- Organs differ in metabolic activity & size

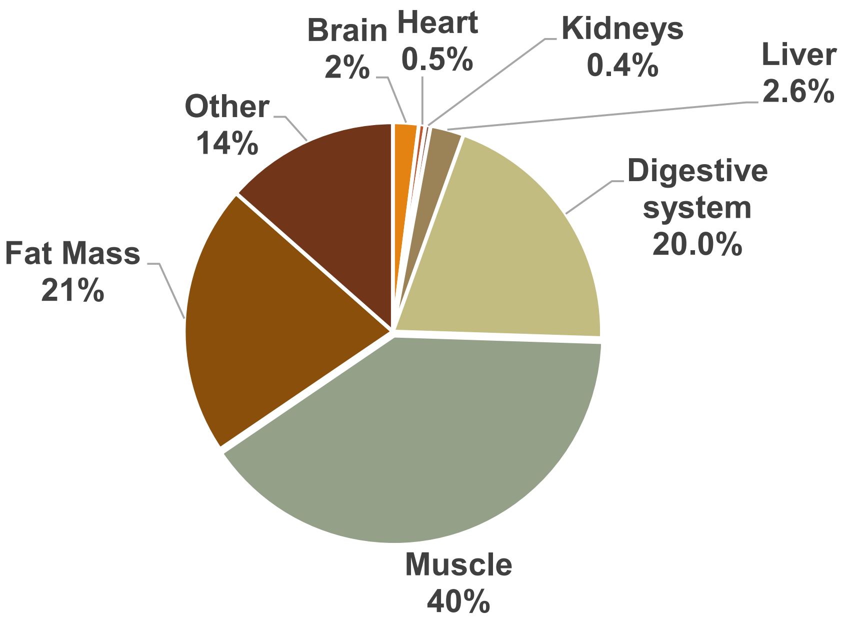


- Basal metabolism

- Digestion
- Physical Activity
- Production (growth)

Organ contribution to body metabolism

% of body weight



- **Metabolic activity based on total weight**
- **Metabolic activity on per unit basis**

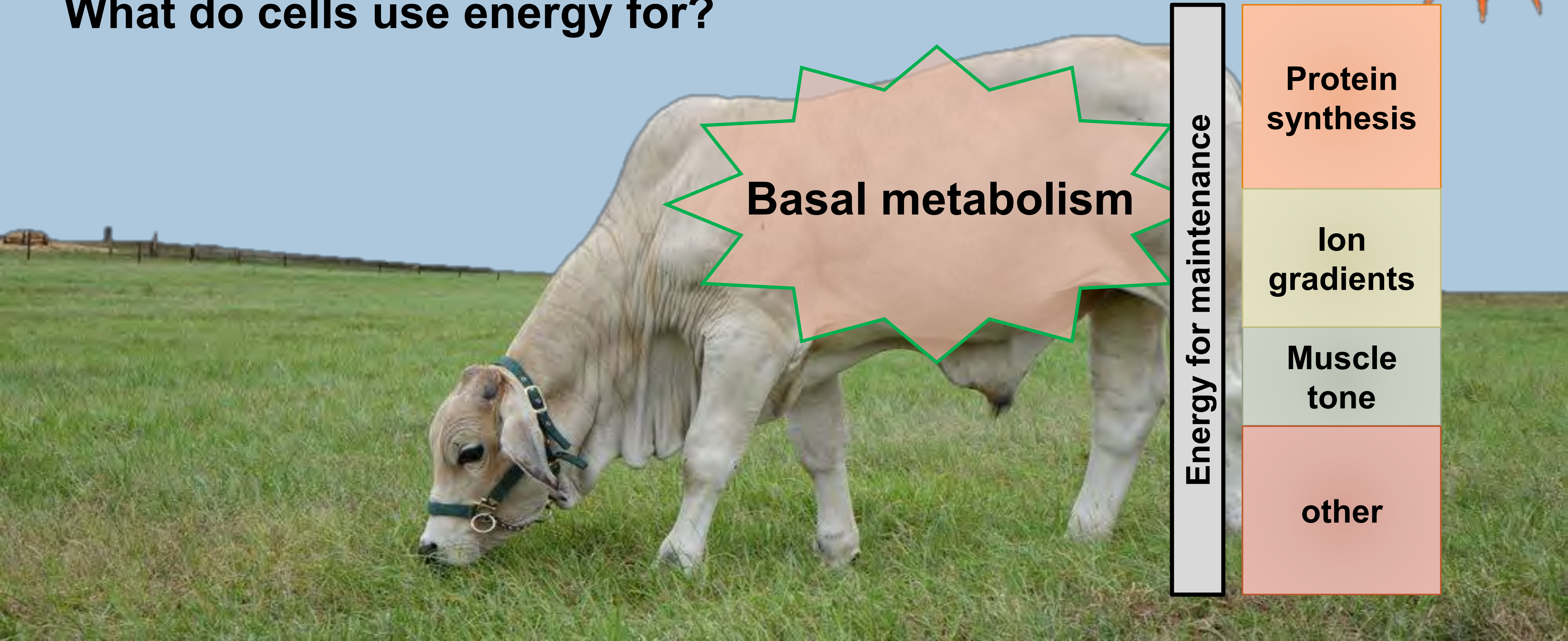
Heat production (metabolic rate) in Brahman

- Lower maintenance requirements
  - Smaller organ size
  - Metabolism on a per unit (cell) basis?

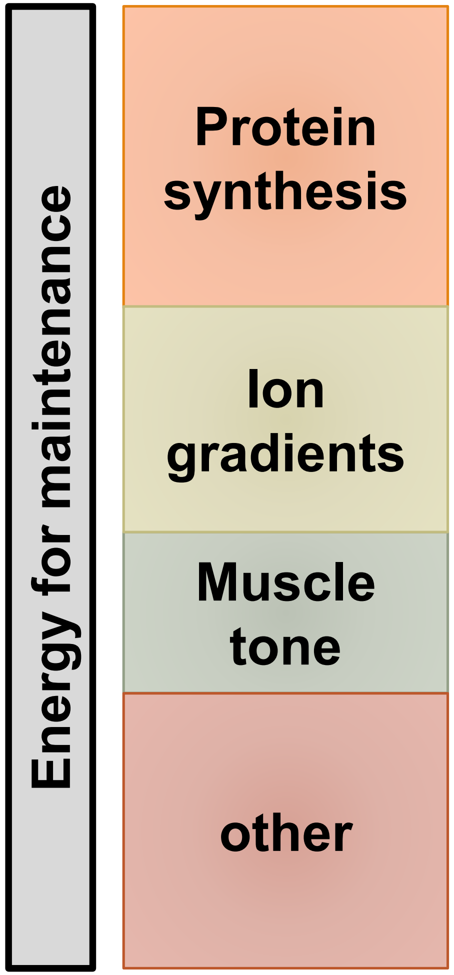
- Basal metabolism
- Digestion
- Physical Activity
- Production (growth)

Heat production (metabolic rate) in Brahman

What do cells use energy for?



What affects energy requirements?



"Uncoupling" processes increase energy demand & metabolic rate

- Protein degradation
- Ion leaks
- Muscle relaxation

Protein metabolism

Protein turnover

Protein Synthesis - Protein Degradation = Protein Deposition

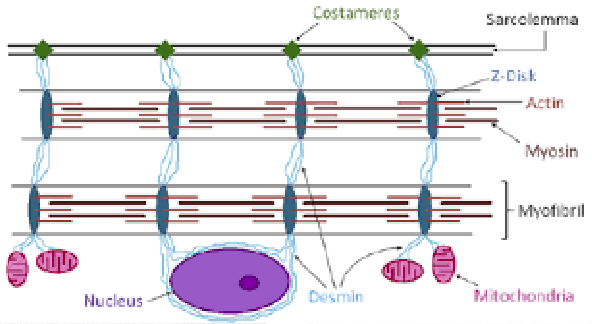
Protein synthesis

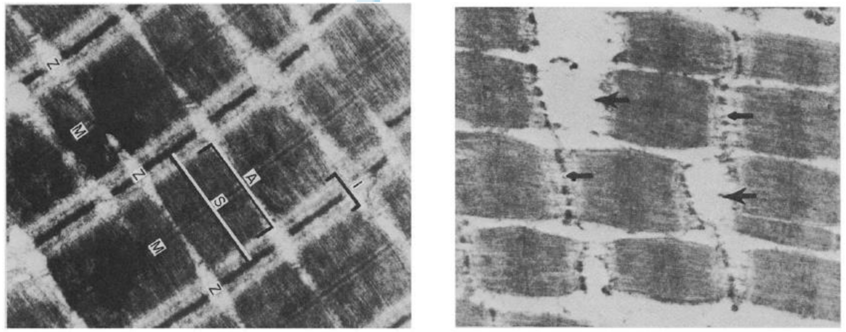
Decrease protein degradation

Limit metabolic rate
Limit heat production

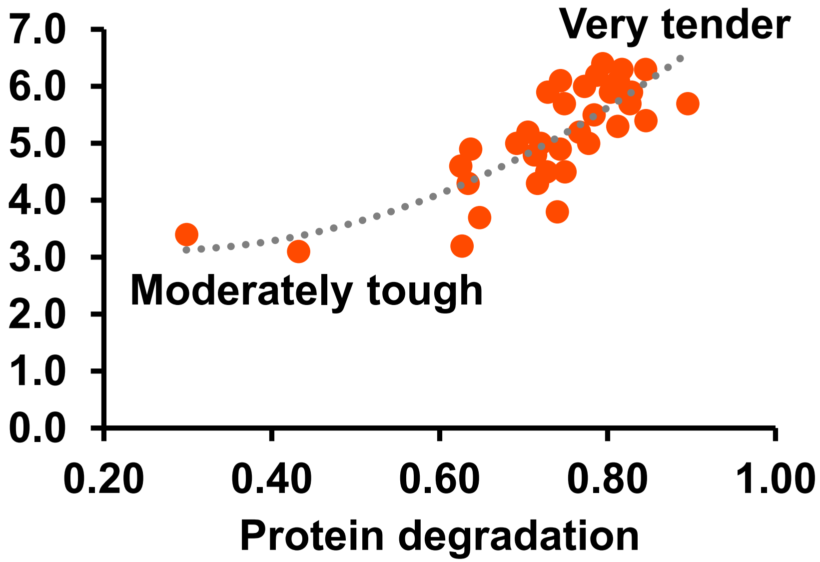
- Heat tolerance?
- Growth rate?
- Meat quality?

Protein degradation contributes to tenderness during meat aging





1h postmortem	24h postmortem



Evaluating postmortem protein degradation

- Calpain (cuts proteins)
- Calpastatin (inhibitor)
- Calpain : calpastatin
- Breakdown of individual proteins

Increasing Brahman composition

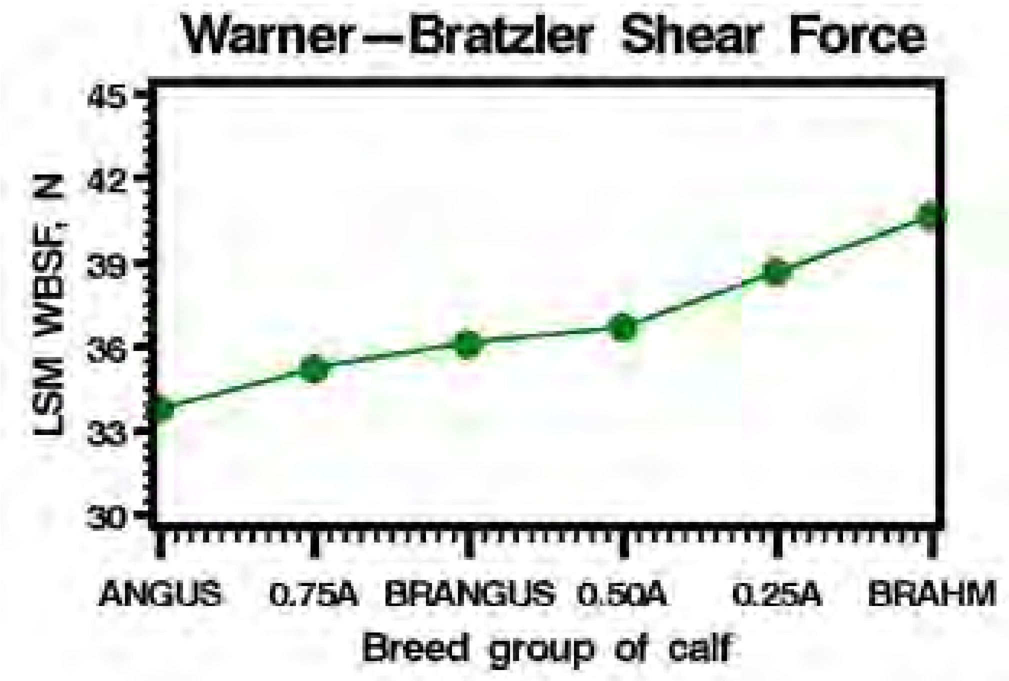
On average, decreases protein degradation and tenderness

- **Decreased protein degradation in living animal?**

- **Hypothesis:**

Slower growing Brahman will have reduced protein synthesis and degradation, resulting in decreased growth rate, low metabolic rate, and greater heat tolerance

…and tougher beef



Elzo et al., 2012

Heat tolerance, growth, & tenderness in Brahman

Select for high & low growth

Acclimation & Heat challenge (2 wk)

Slaughter
UF Meat Lab

Calves born

Weaning

Finishing at BTU

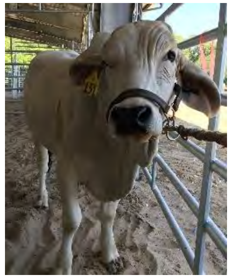
Dec.-Feb.

Aug.

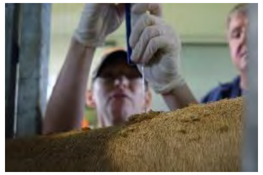
Oct.

June

Dec.

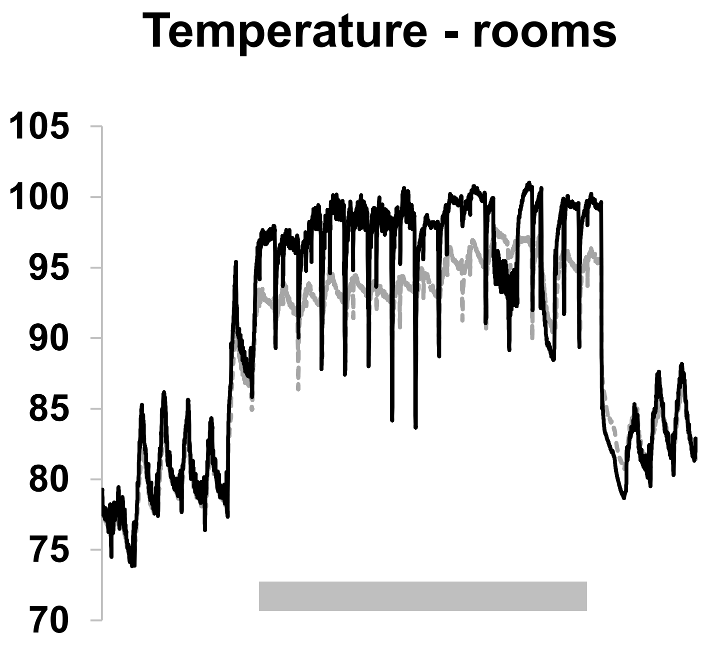


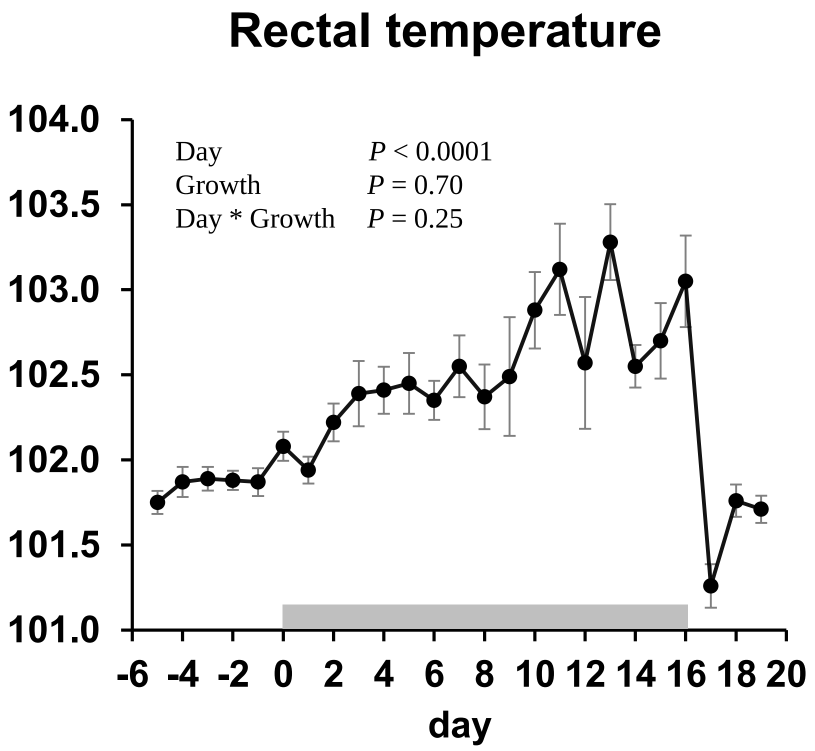
- Carcass data
- Muscle samples – protein degradation
- Aged steaks for tenderness

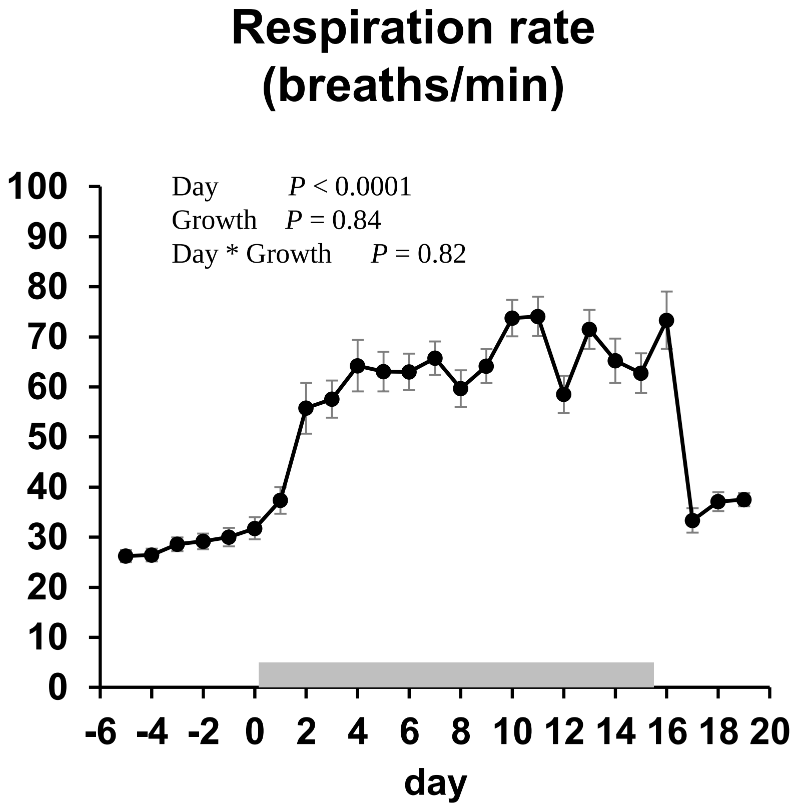


- Respiration
- Temperature
- Biopsy (pre- and post-)

Heat challenge

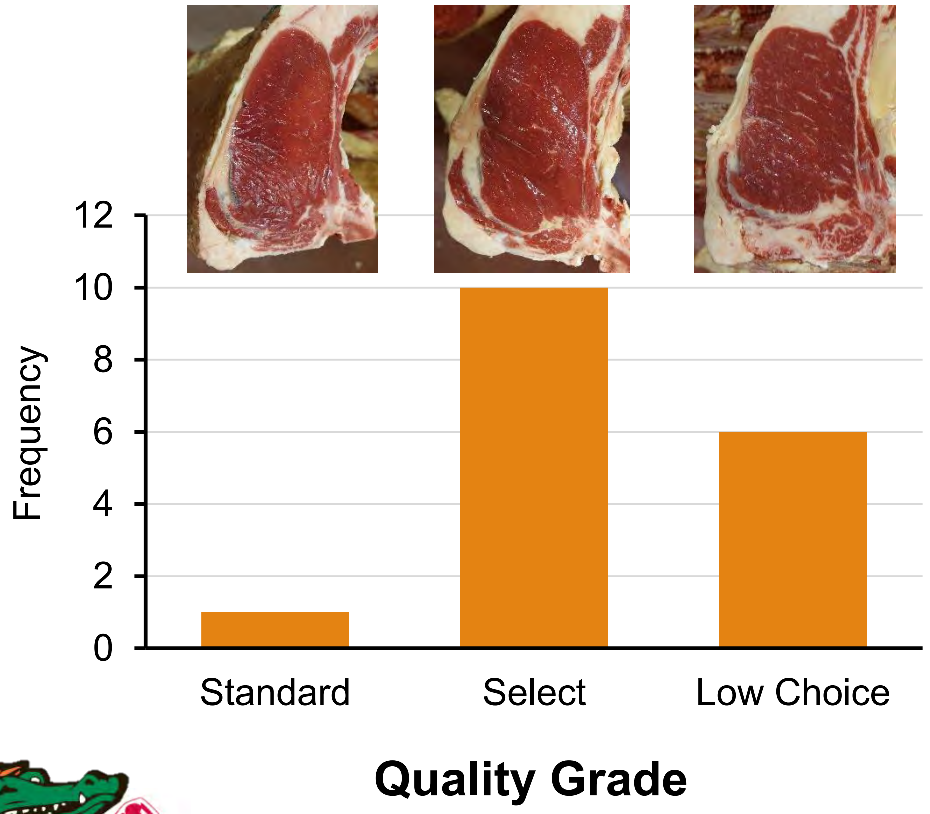






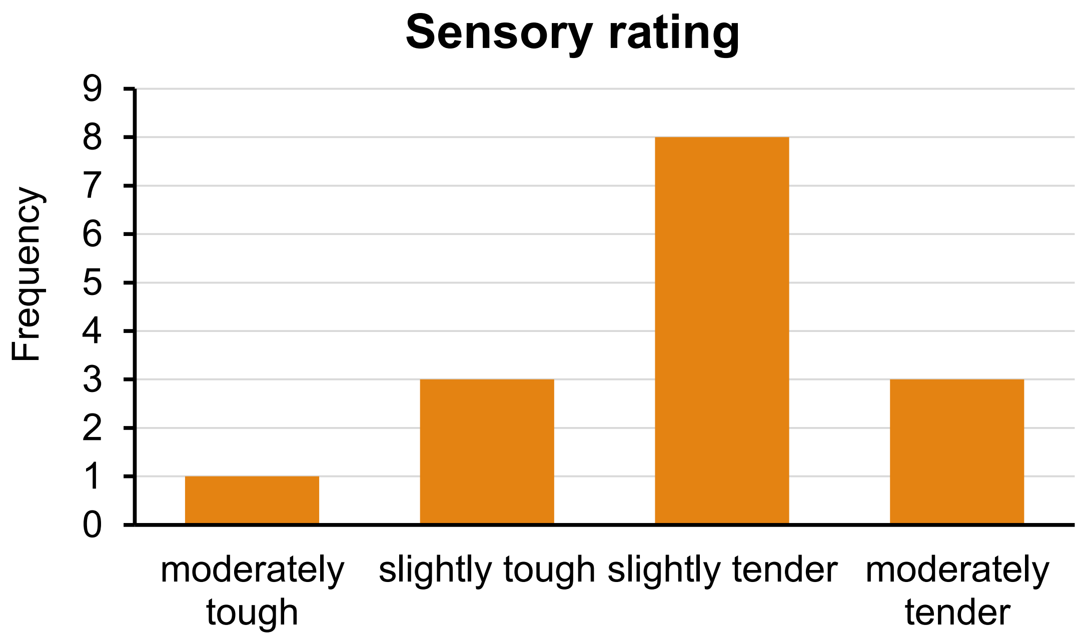
Meat quality

(n = 16 total)



Tenderness

Avg shear force = 3.1 kg (2.1 – 3.7 kg)



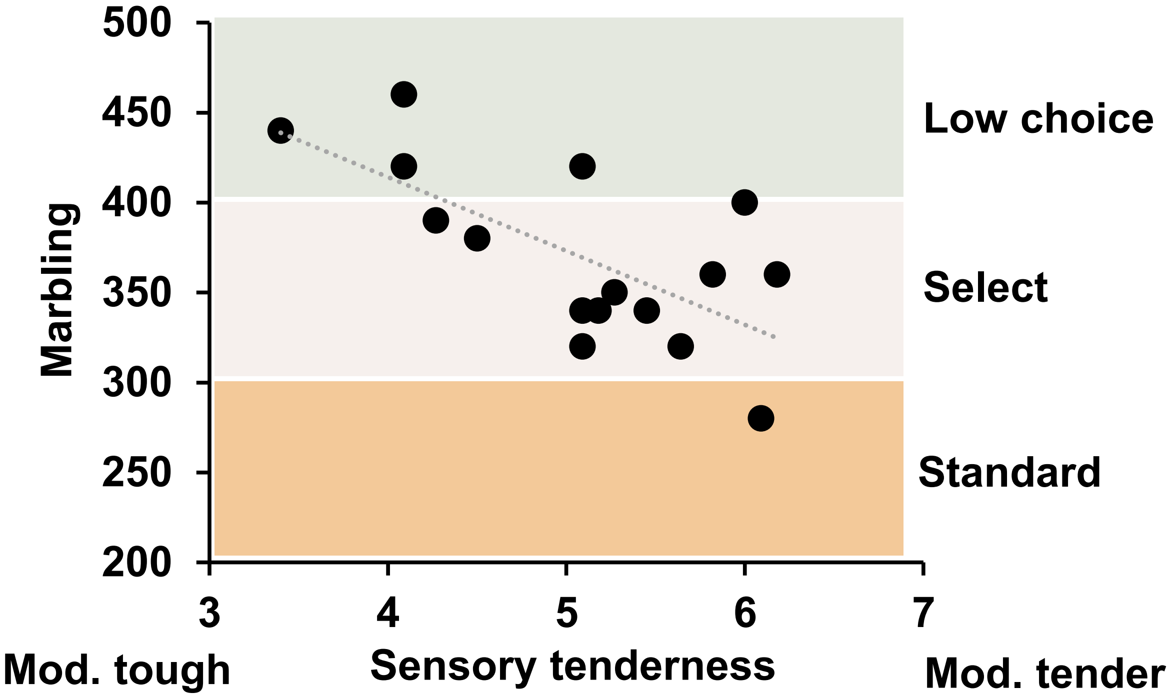
Brahman & tenderness

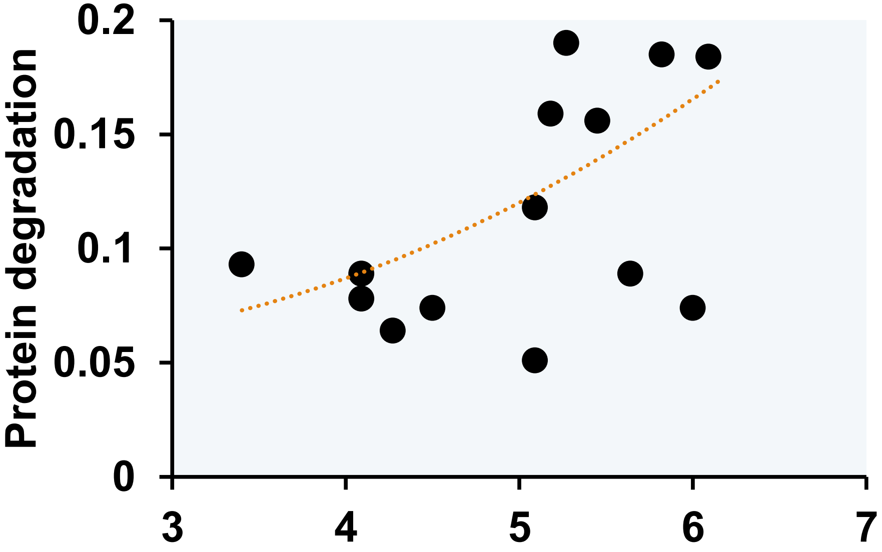
- **Marbling ?**

  Not improving sensory tenderness

- **Protein degradation?**

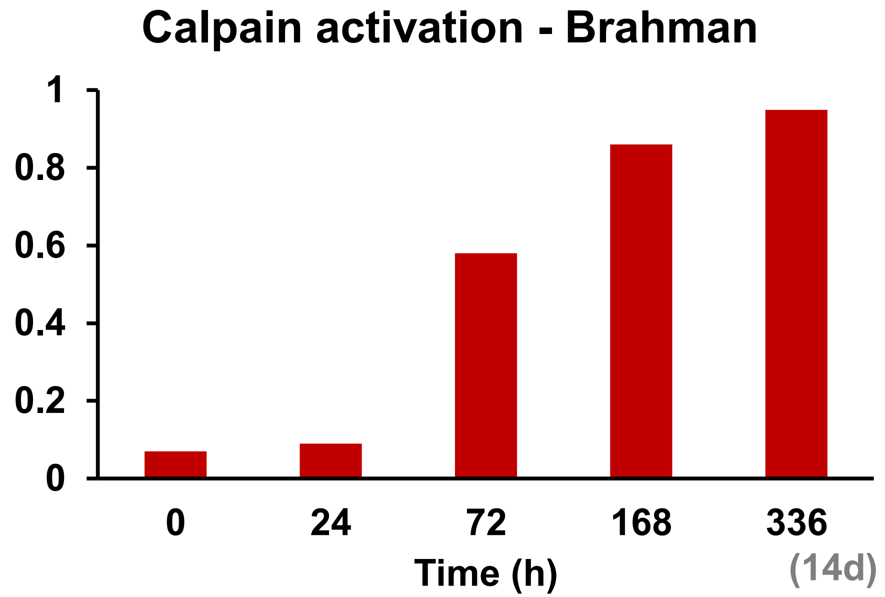
  Improves likelihood for favorable tenderness

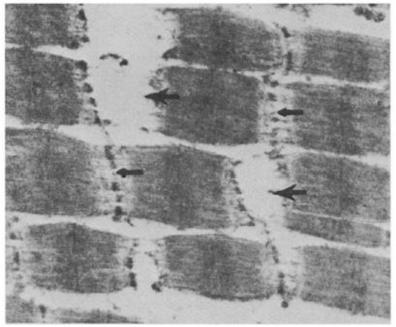


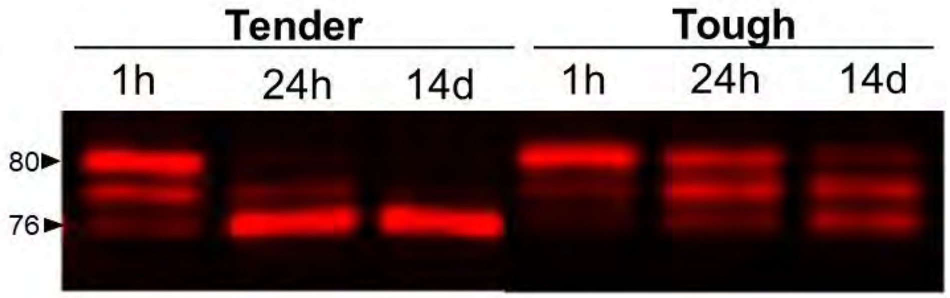


Postmortem protein degradation in Brahman

- Calpain activation
  - Slower in Brahman
  - Slower activation ↑ toughness







What affects calpain activation?

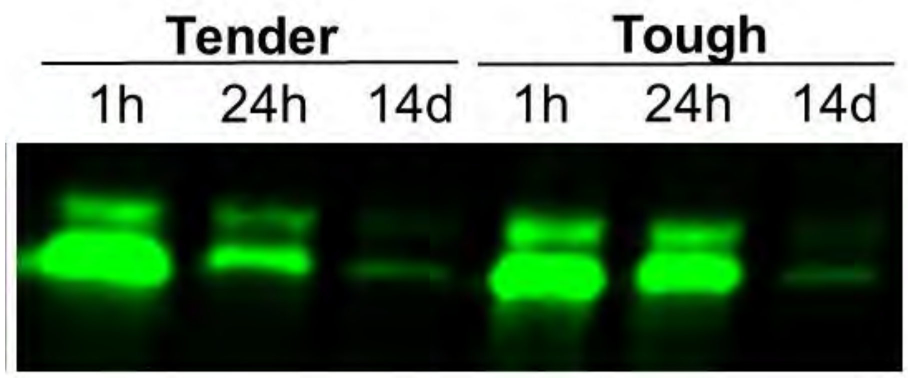
Calpastatin (inhibitor)

- Slower disappearance in tougher steaks
- Degraded by calpain
- Greater content?
- Capacity for inhibition?

- Calcium
- Temperature
- pH

Postmortem metabolism

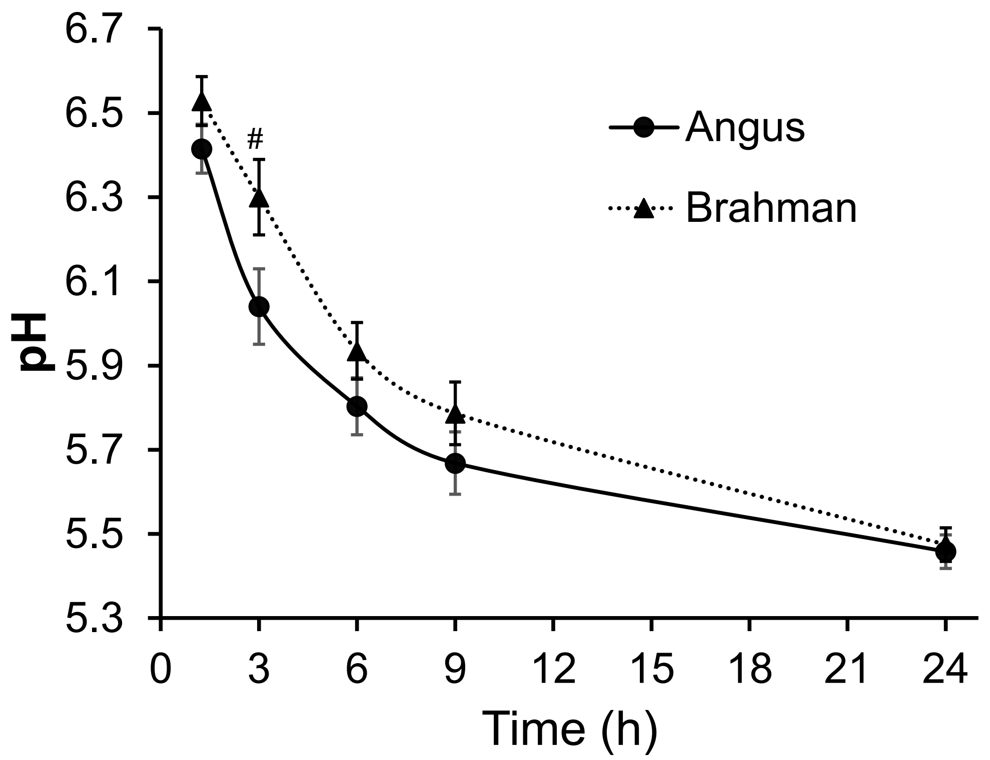
Calpastatin

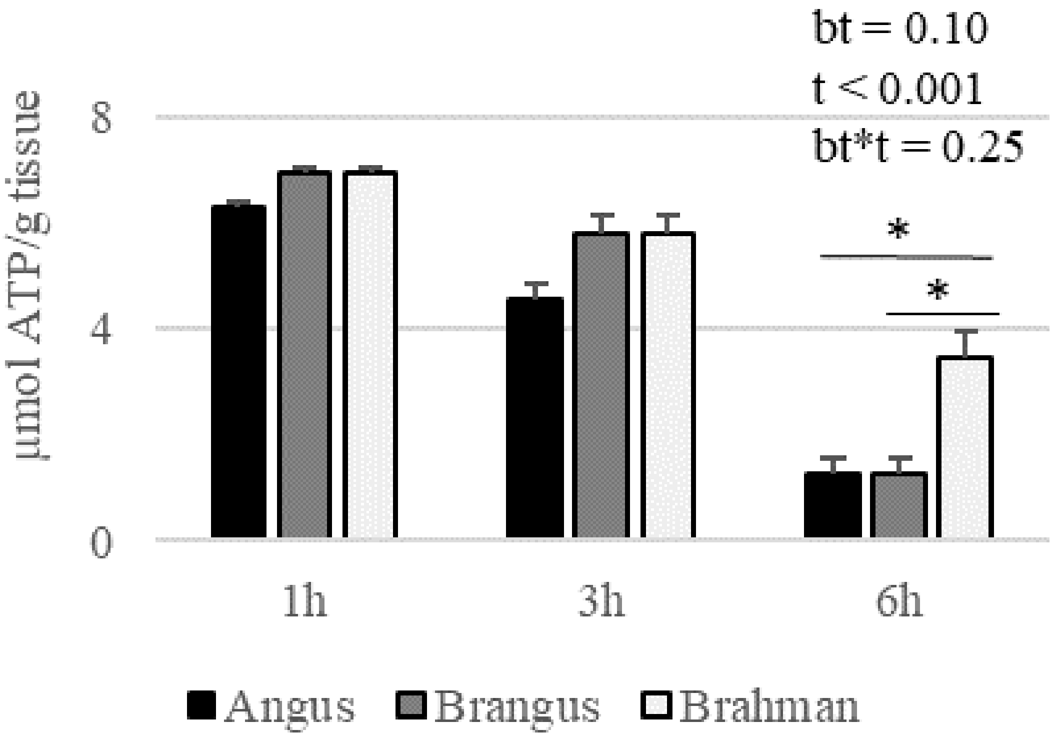


Postmortem metabolism: Conversion of muscle to meat

	Living muscle
pH	7.2
Temp.	101°F
Energy	Stable / recoverable
Intracellular	Calcium tightly controlled

Postmortem metabolism in Brahman



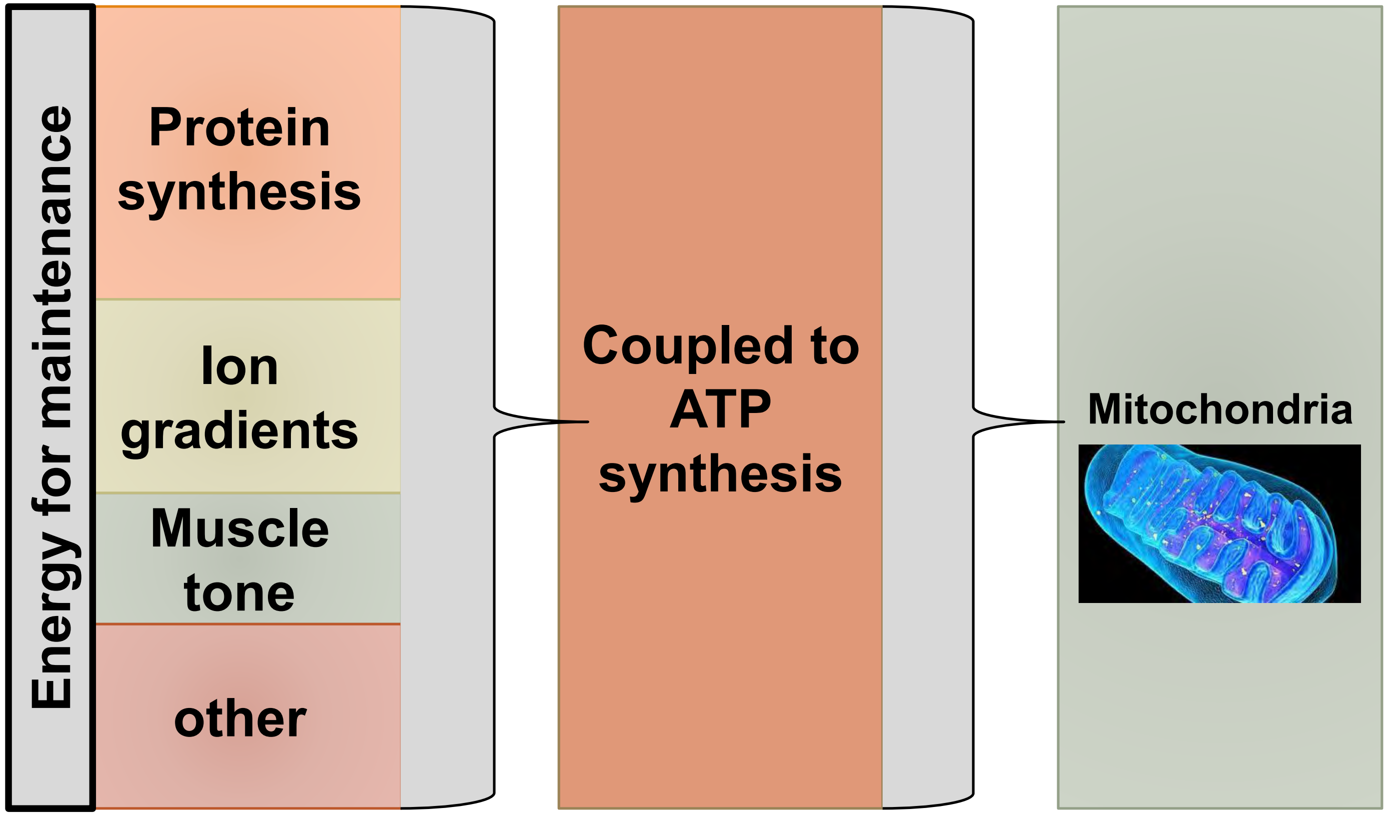


- **More resistant to pH changes**
- **Improved maintenance of energy status (ATP)**

Even in death, Brahman are resilient

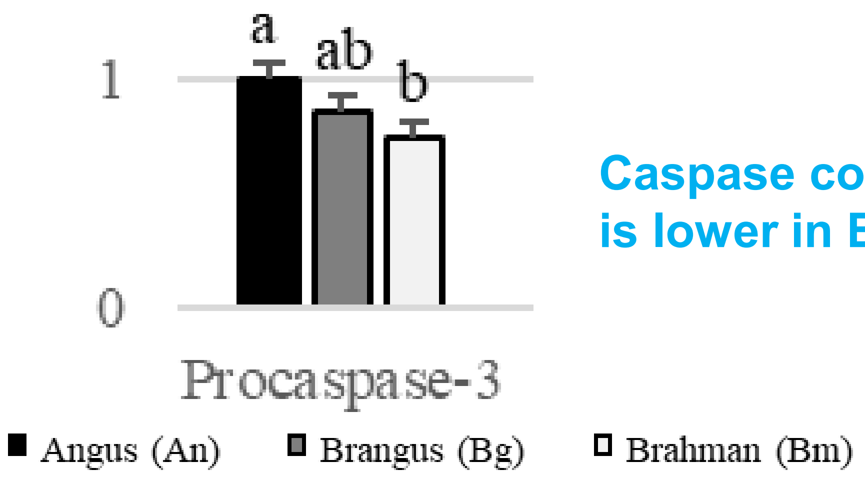
A role for mitochondria?

- **ATP production**
- **Calcium sequestration**
- **Mito-mediated cell death**



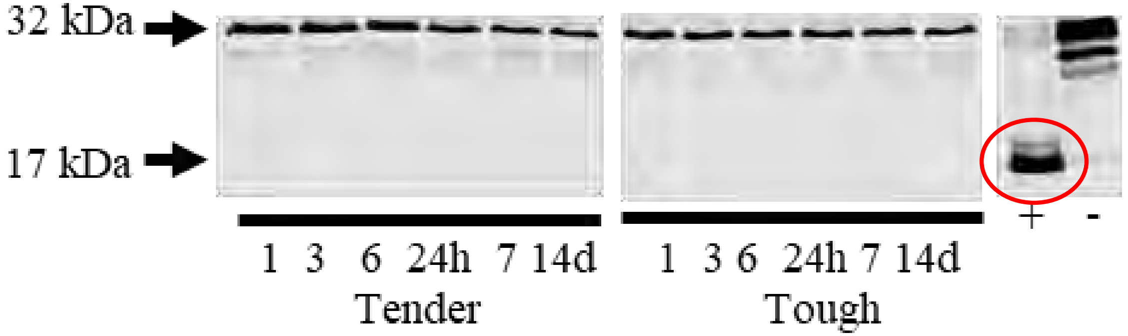
Mitochondria-mediated (programmed) cell death

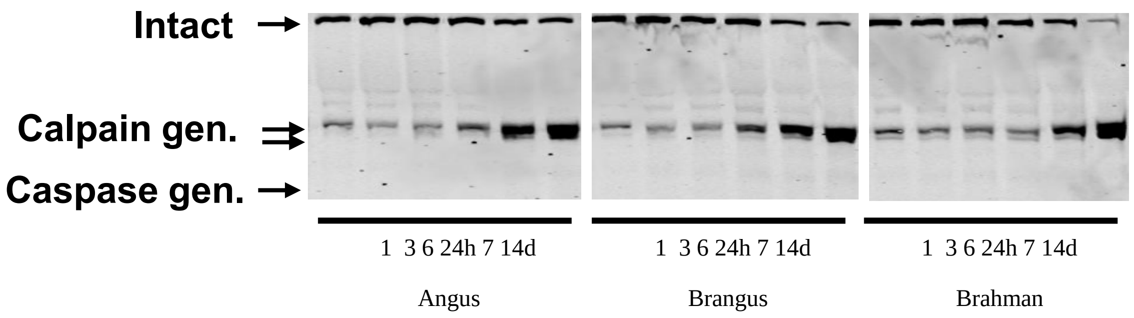
- Angus, Brangus, Brahman
- Caspases?



Caspase content – is lower in Brahman

Caspase is not cleaved (activated)

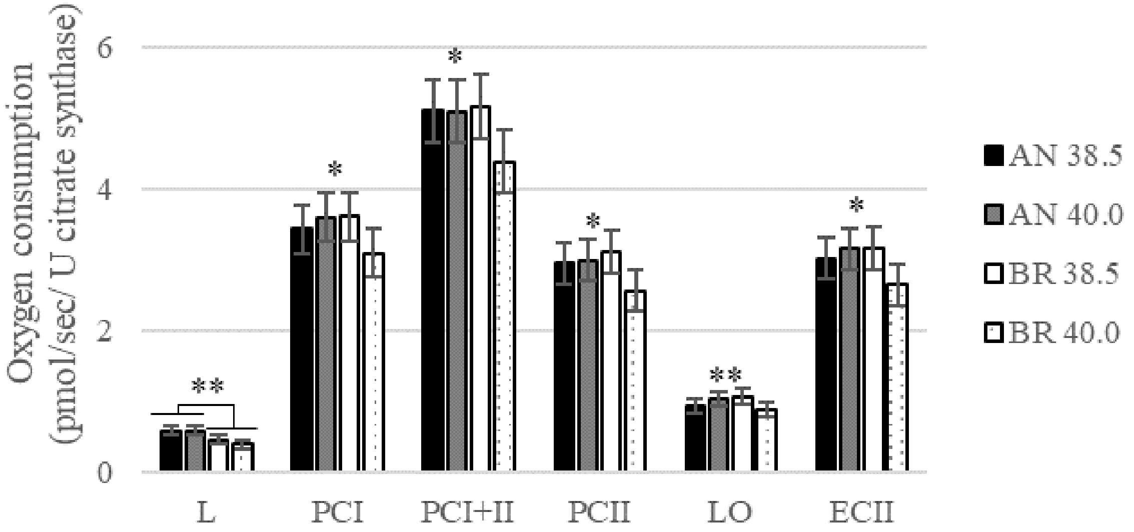




Little support for a role for caspase postmortem!

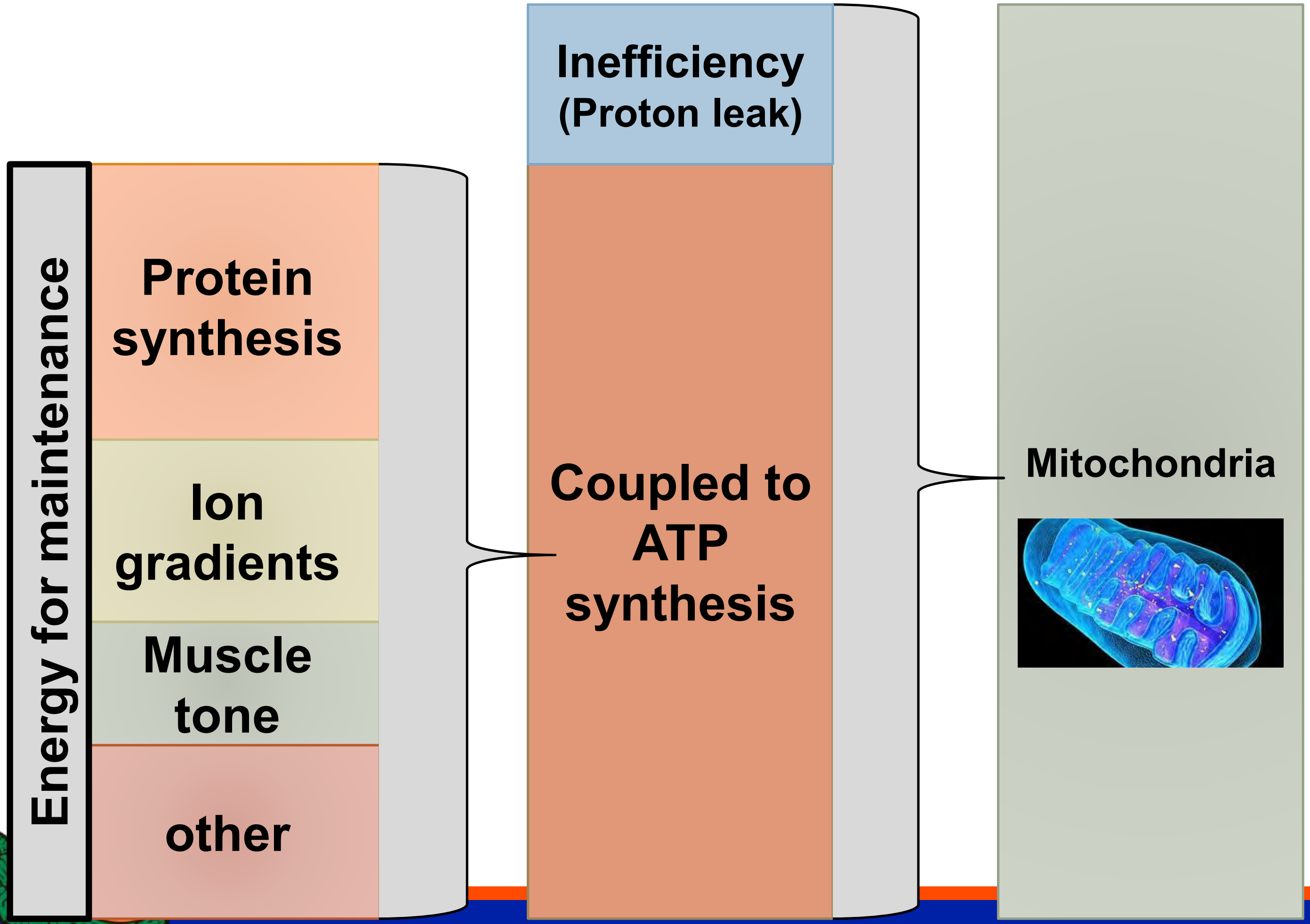
Mitochondria function postmortem

- Does muscle from Angus & Brahman function differently early postmortem?
- Does temperature change functional properties?

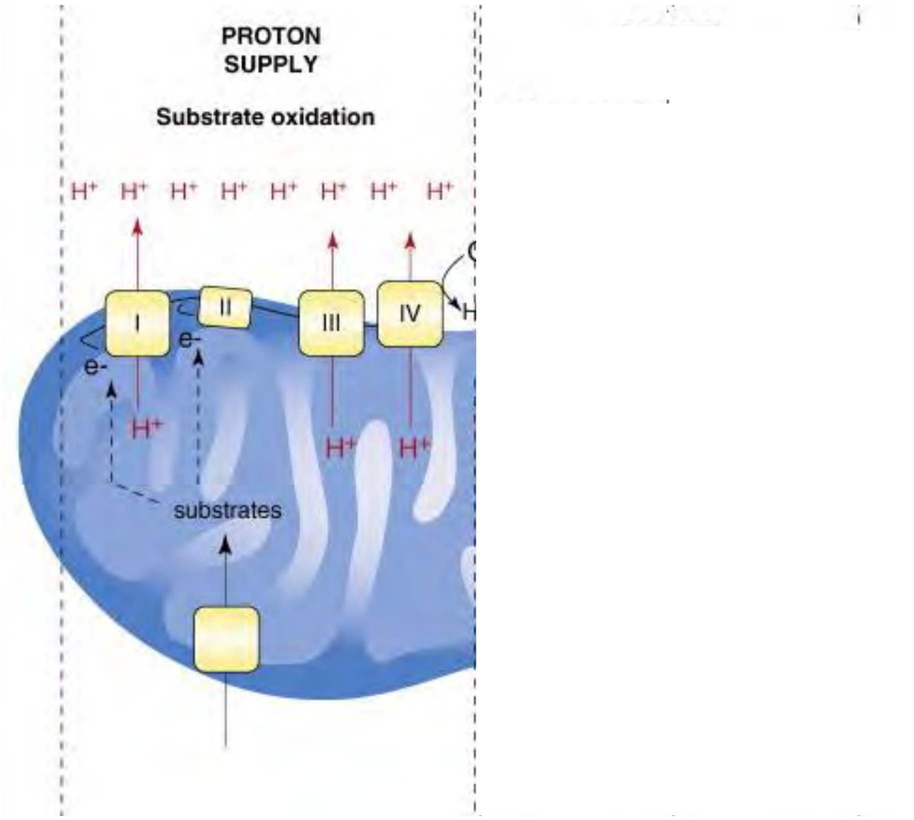


- **At 1h, mitochondria can work and are coupled (produce ATP)**
- **Brahman decrease oxygen consumption at higher temperature**

Other ways to decrease heat production?

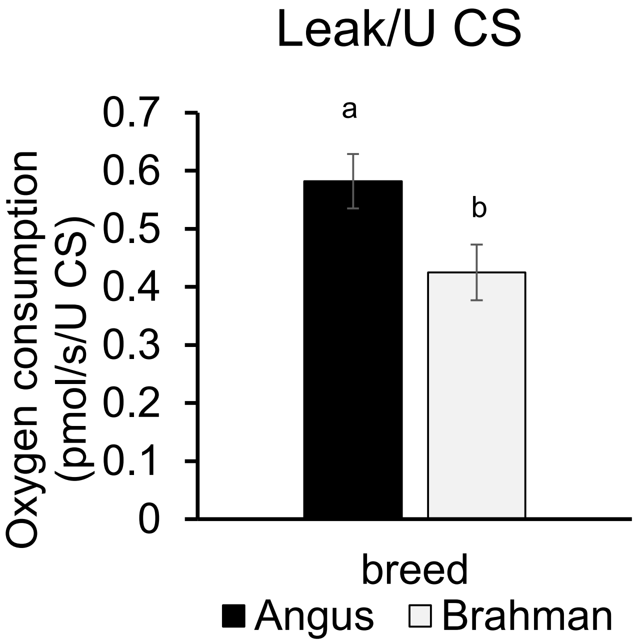


Limit mitochondrial leak



Brahman vs. Angus Mitochondrial function

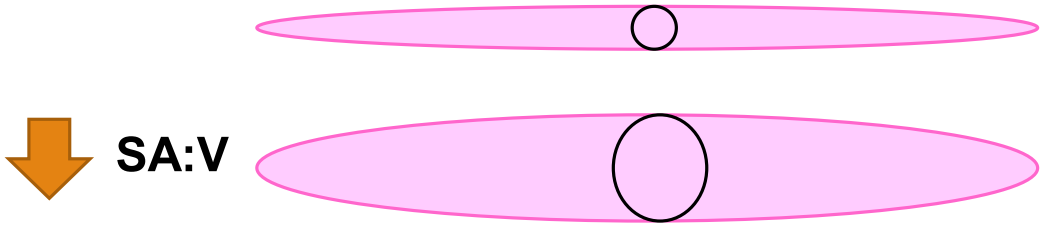
- *Longissimus* - 1h postmortem

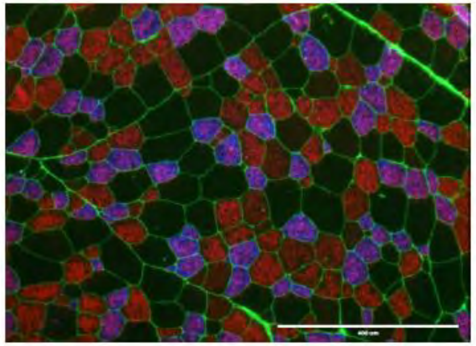


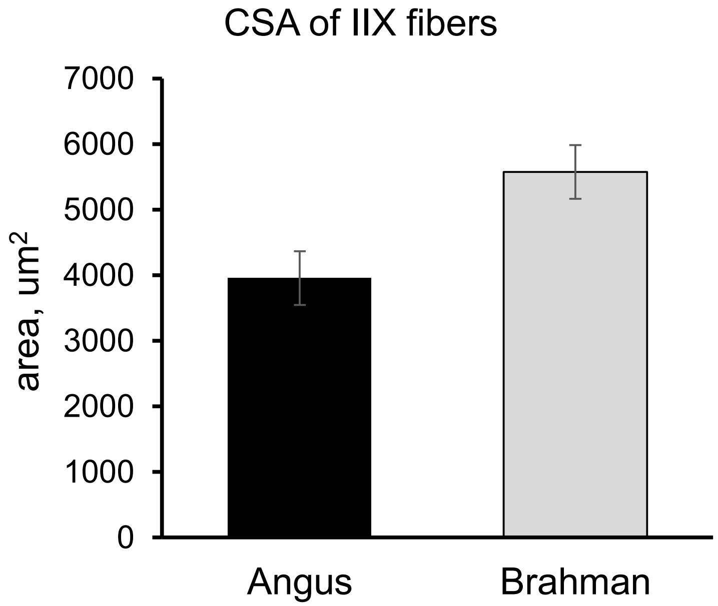
Breed, effect *P* = 0.02

Muscle Na/K ATPase and metabolic rate

- **Increasing fiber size is metabolically advantageous** (Jimenez et al., 2013)
  - **Decreasing surface area:volume reduces metabolic cost of maintaining membrane potential**







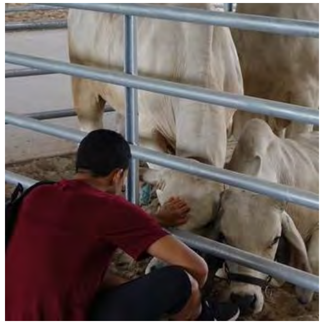
Adapted from Wright et al., Meat Sci., 2018

Conclusions

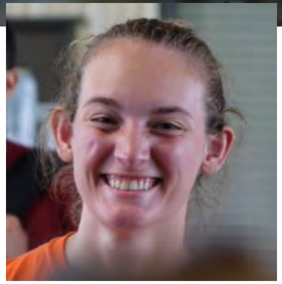
- Cellular energy metabolism is an important contributor to heat production
- Several possible adaptations that may help reduce heat production in Brahman
- Muscle function in life may be antagonistic to meat quality parameters. Evaluate and balance consequences for pasture vs. plate.

Thank you!







Funding:
Florida Cattle Enhancement Board
NIFA-USDA Product Quality

Heat loss in Brahman

Smooth, slic