Maternal Influences on the Calf Rumen Microbiome and Subsequent Impacts on Performance and Efficiency

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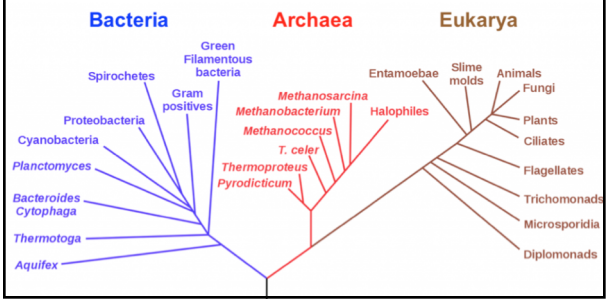
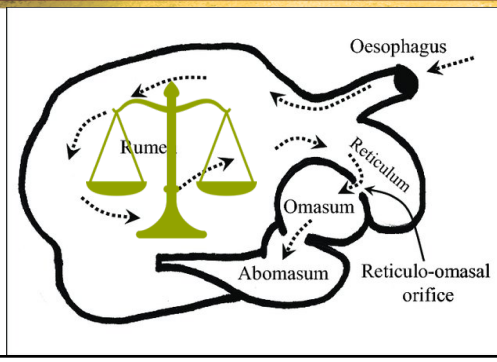
The Rumen Microbiome

- What is it?
  - The microbial community (and it's genetic material) that inhabits the rumen
- 1950's – Robert Hungate

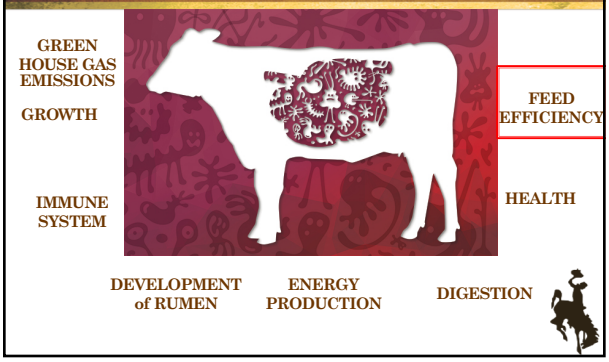
Types of Rumen Microbiota



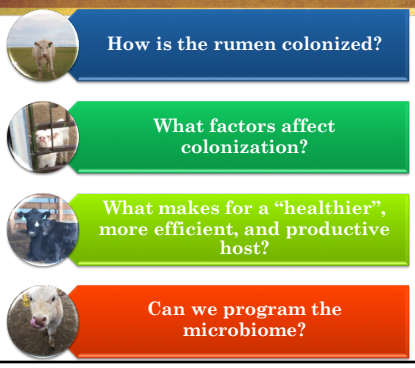
The "Healthy" Rumen Microbiome



Why do we care?



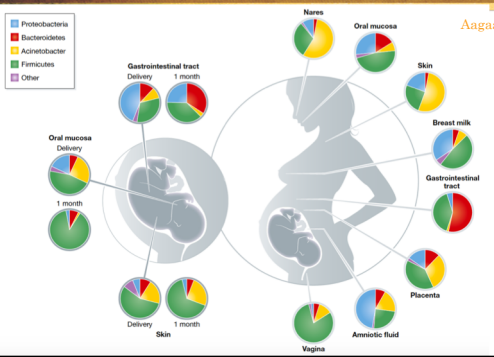
What is our goal?



Inoculation of the Rumen

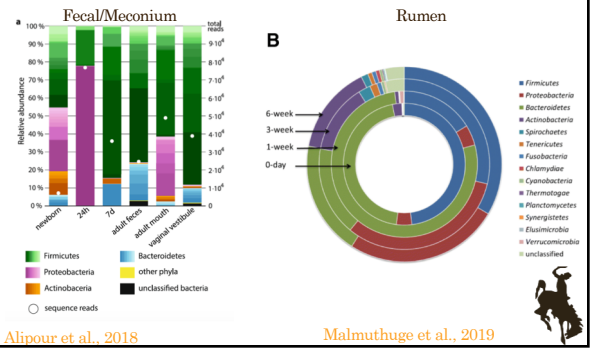
- Believed to be "sterile" at birth
- Source of inoculation
  - Birth canal
  - "Maternal" factors
    - Licking, suckling, etc.
    - Colostrum
  - Consumption of bedding, hay, etc.
- What about pre-parturition factors?

Pre-Parturition Factors



Aagaard et al., 2016

Evidence in Ruminants

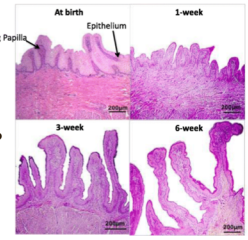


Alipour et al., 2018

Malmuthuge et al., 2019

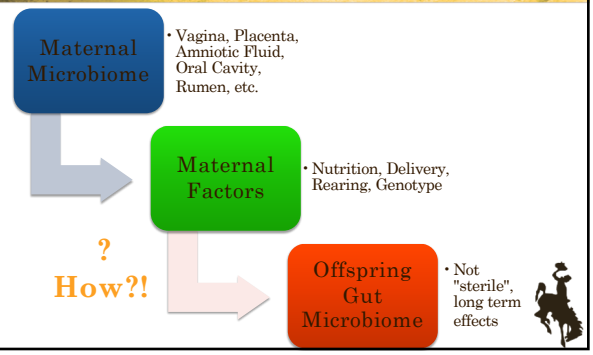
Importance of the Early Microbiome

- Setting up fermentation patterns
- Production of VFA that are critical for rumen development (especially the papillae; Church, 1988)
- Immune system
  - Ruminal microbe/immune cell homeostasis (Garcia et al., 2017)
- Optimum stage for intervention?
  - Programming potential (Abecia et al., 2014a, 2014b, 2013; Yáñez-Ruiz et al., 2010)



Malmuthuge et al., 2019

Establishment of the Rumen Microbiome



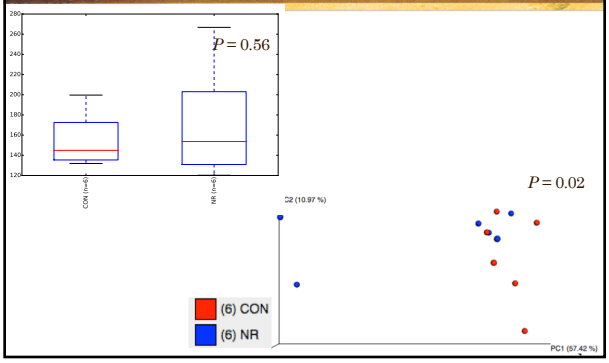
What we have done thus far…

- Three studies
  - 1) Maternal Gestational Nutrition & Mode of Delivery
  - 2) Maternal Genotype & Pre- and Post-Parturition Factors
  - 3) Survey of the maternal microbiomes

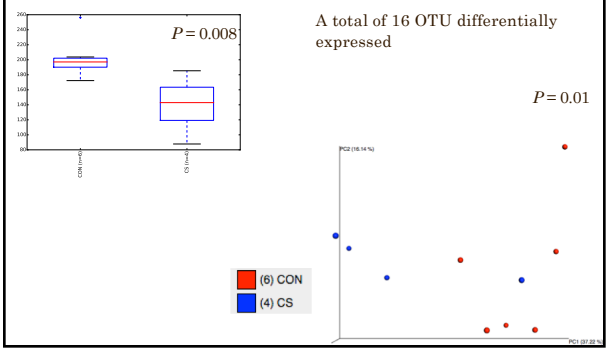
**A brief methodology

- Collect rumen fluid
  - Oral lavage
- Isolate *microbial* DNA
- Sequence DNA
- Analyze sequences
  - Alpha-diversity
    - How "rich" or "even"
  - Beta-diversity
    - What does the composition look like?
  - Taxa abundances

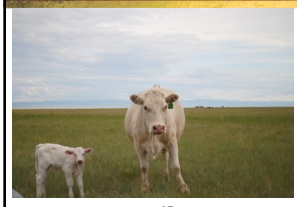
Alpha and Beta Diversity – CON vs. NR



Alpha and Beta Diversity – CON vs. CS

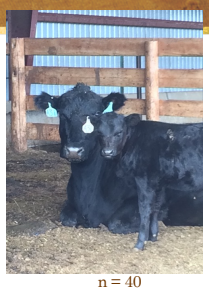


Maternal Breed – Two Divergent Breeds



n = 42

VS.



n = 40

- This project was supported by Agriculture and Food Research Initiative Competitive Grant no 2016-67016-24903 from the USDA National Institute of Food and Agriculture

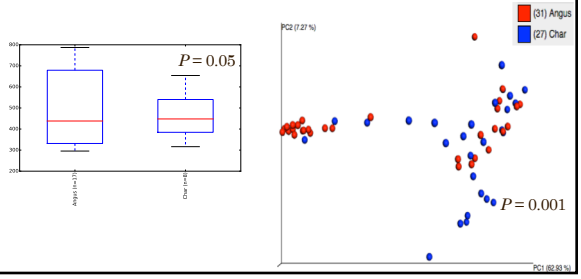
Treatment Groups – Within Each Breed

Cows fed ad libitum grass hay (supplemented with DDGS)and separated by breed prior to parturition and by treatment group from parturition through weaning

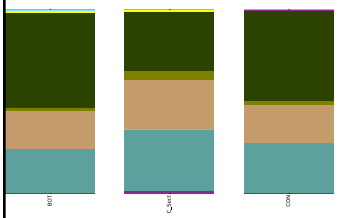
Control	Natural Delivery	Raised respective calves through weaning
Caesarean Delivery	Caesarean Delivery	Raised respective calves through weaning
Bottle Reared	Natural Delivery	Calves removed from dam 24 hr post-parturition

Breed Differences

- Breed differences become more pronounced as the animal matures



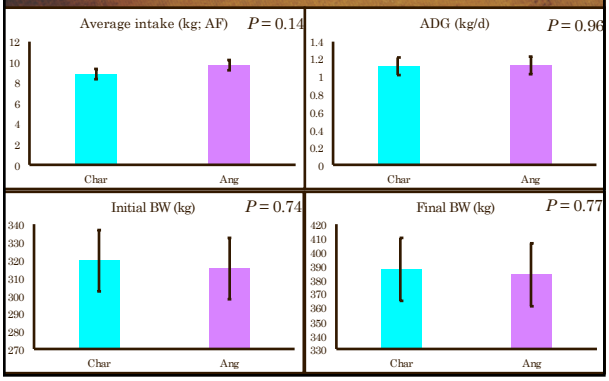
Mode of Delivery and Rearing



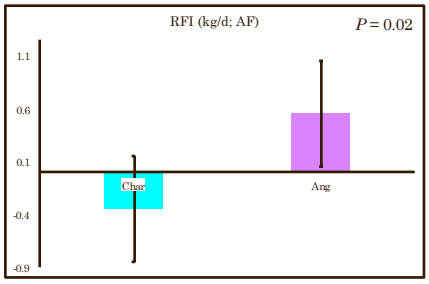
- Less prominent as the animal matures
- Unknown what impact these treatments had on tissue level development & health

Feed Efficiency and the Rumen Microbiome

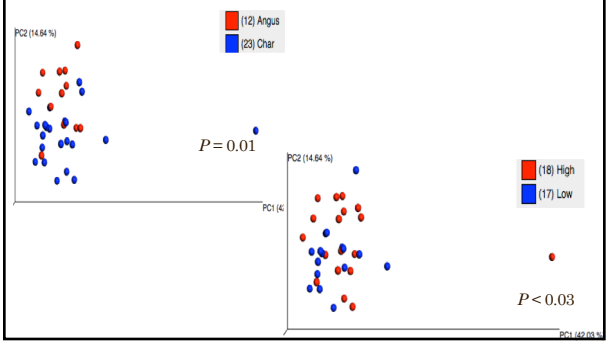
Feed Test Data – Breed



Feed Test Data – Breed



Feed Test Microbiome



Conclusions & Implications

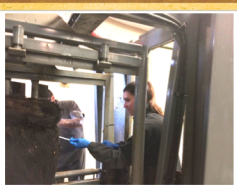
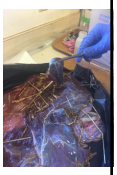
- Day is a driving factor in rumen physiology
  - Microbiome
    - Abundance, alpha- and beta-diversity
- Maternal factors affect the rumen microbiome, microbial fermentation, and performance
  - Mode of delivery and rearing type → some differences persist
  - Maternal breed →more pronounced as animal matures
  - Gestational nutrition → at least early on, calves microbiomes differ
- Potential for programming and intervention
  - But how does colonization happen?

Ongoing Study

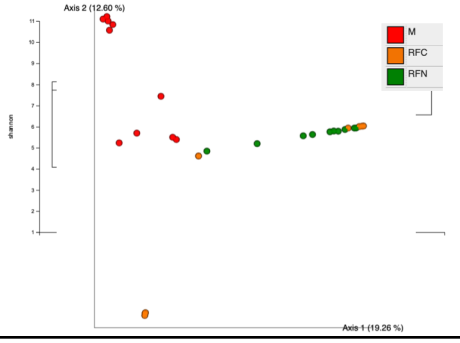
- Survey of maternal "sources" of inoculation to the rumen microbiome
  - Objectives:
    - 1) To evaluate several maternal microbiomes yet to be evaluated in beef cattle
    - 2) To compare those maternal microbiomes with the developing calf gut microbiome

Methods – Cow Samples

- Prior to calving:
  - Rumen fluid
  - Vaginal Swab
  - Amniotic Fluid
- After calving:
  - Placental samples
  - Calf samples
    - Meconium, blood, rumen fluid
    - Feed efficiency

Results Thus Far



Our objective:

- *Phase 1: Investigate potential mechanisms of colonization/inoculation*
- *Phase 2: Investigate intervention strategies that can alter/program the microbiome*

Thank you!

- Kathy Austin
- Gwen Hummel
- Kelly Woodruff
- Ryan Knuth
- Beef Unit Crew
  - Travis Smith
- Dr. Kristi Cammack

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THE WORLD NEEDS MORE COWBOYS.