Assessing the Impact of Changing Diets on the Gut Microbial Community of Developing Dairy Calves

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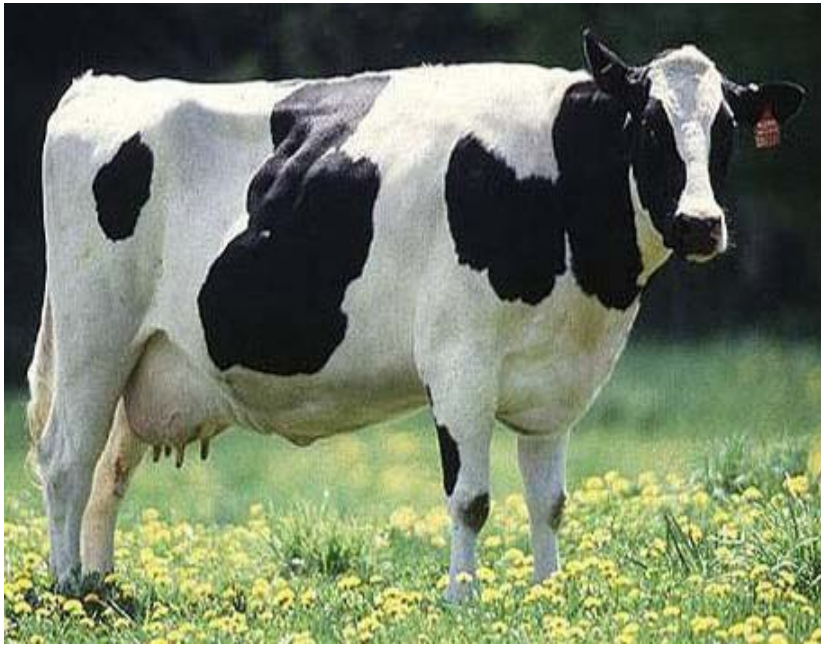
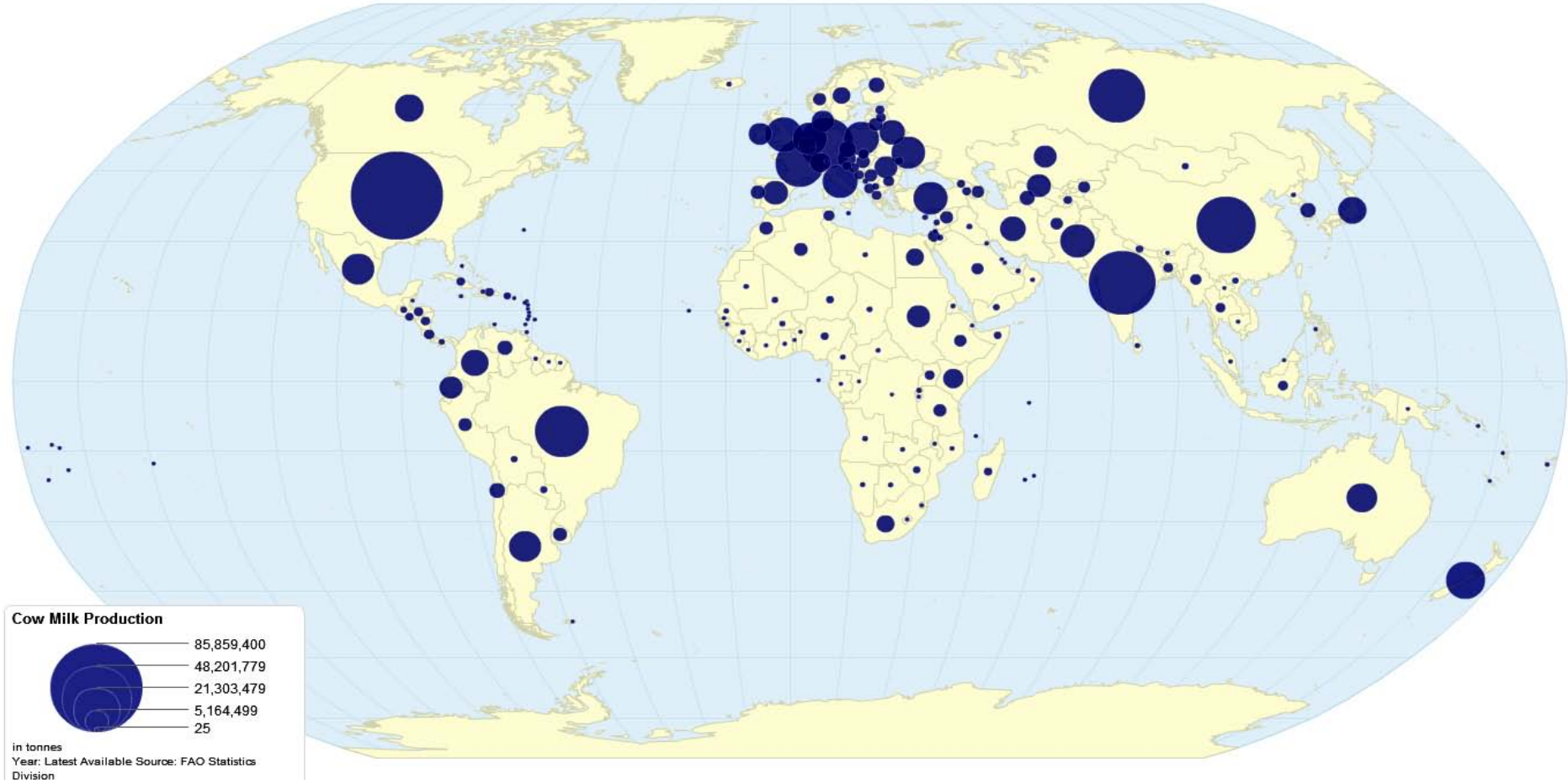
Research in our Lab

Understand the role of the gut microbial community (microbiota) in herbivores and their influence on host biology



Can we modify the rumen microbiota of a cow to improve milk production efficiency?

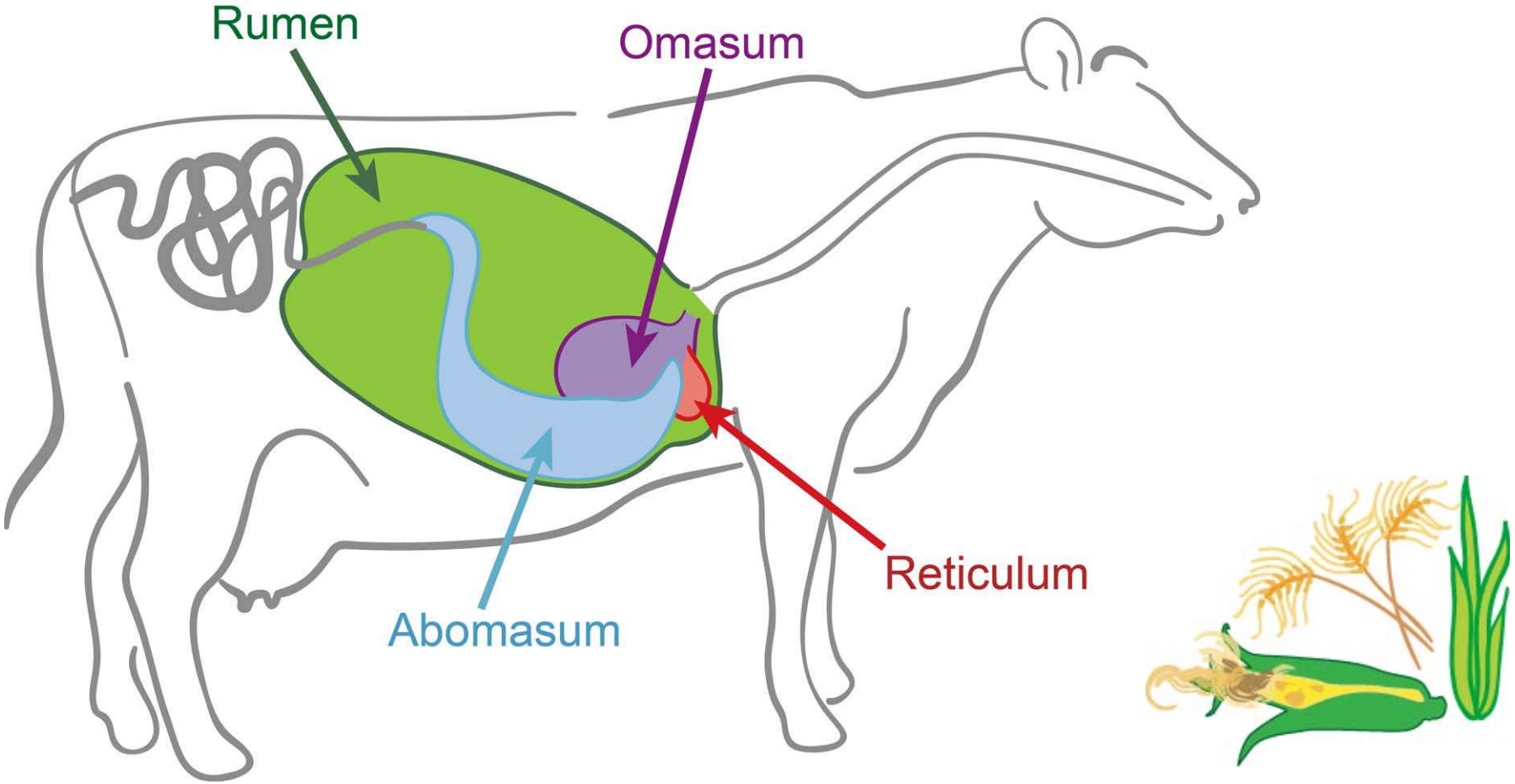
- National milk production at $35 billion in 2012
- Wisconsin 1st in cheese, 2nd in milk, nationally



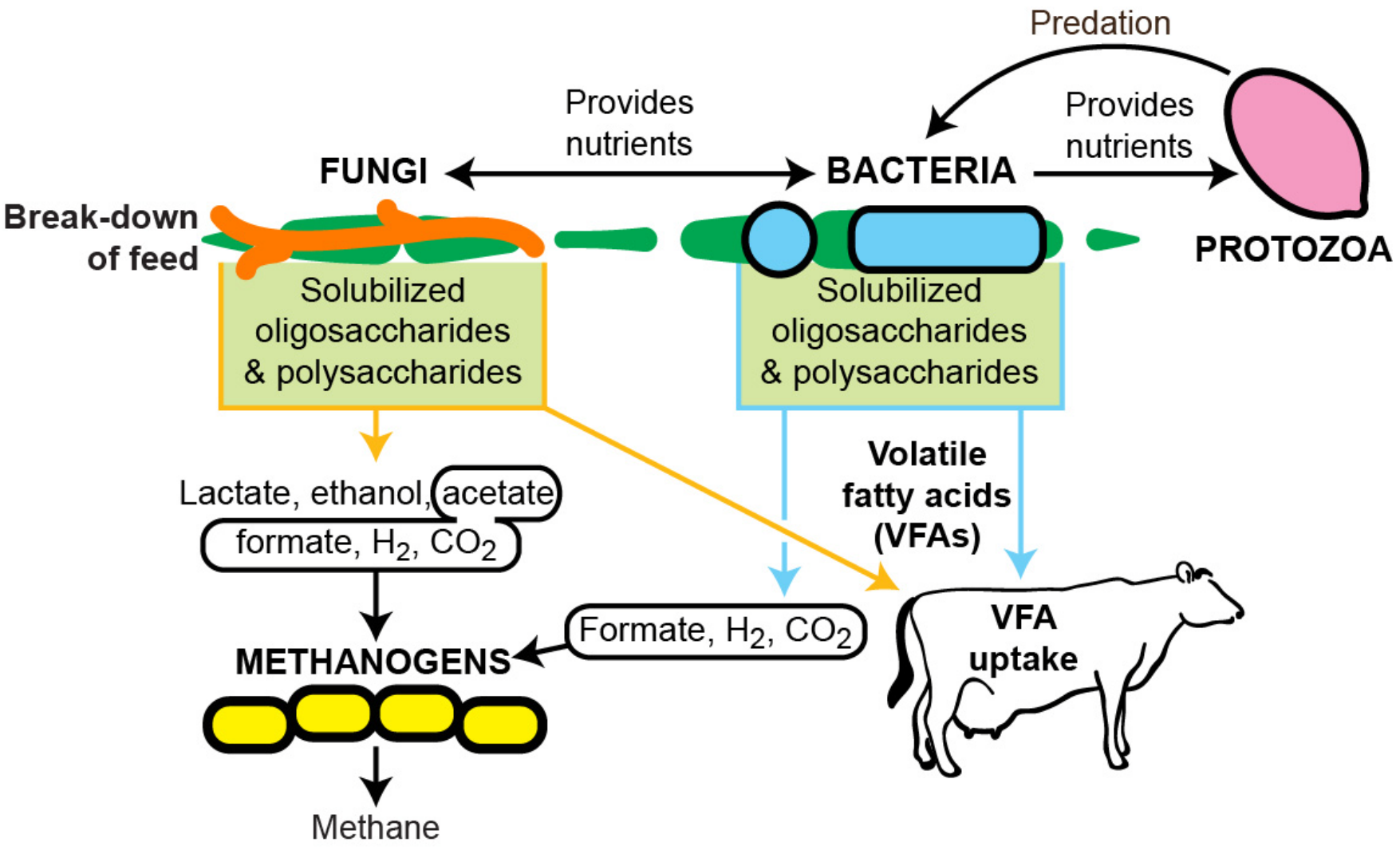
http://chartsbin.com

USDA/NASS 2012

Anatomy of a Cow

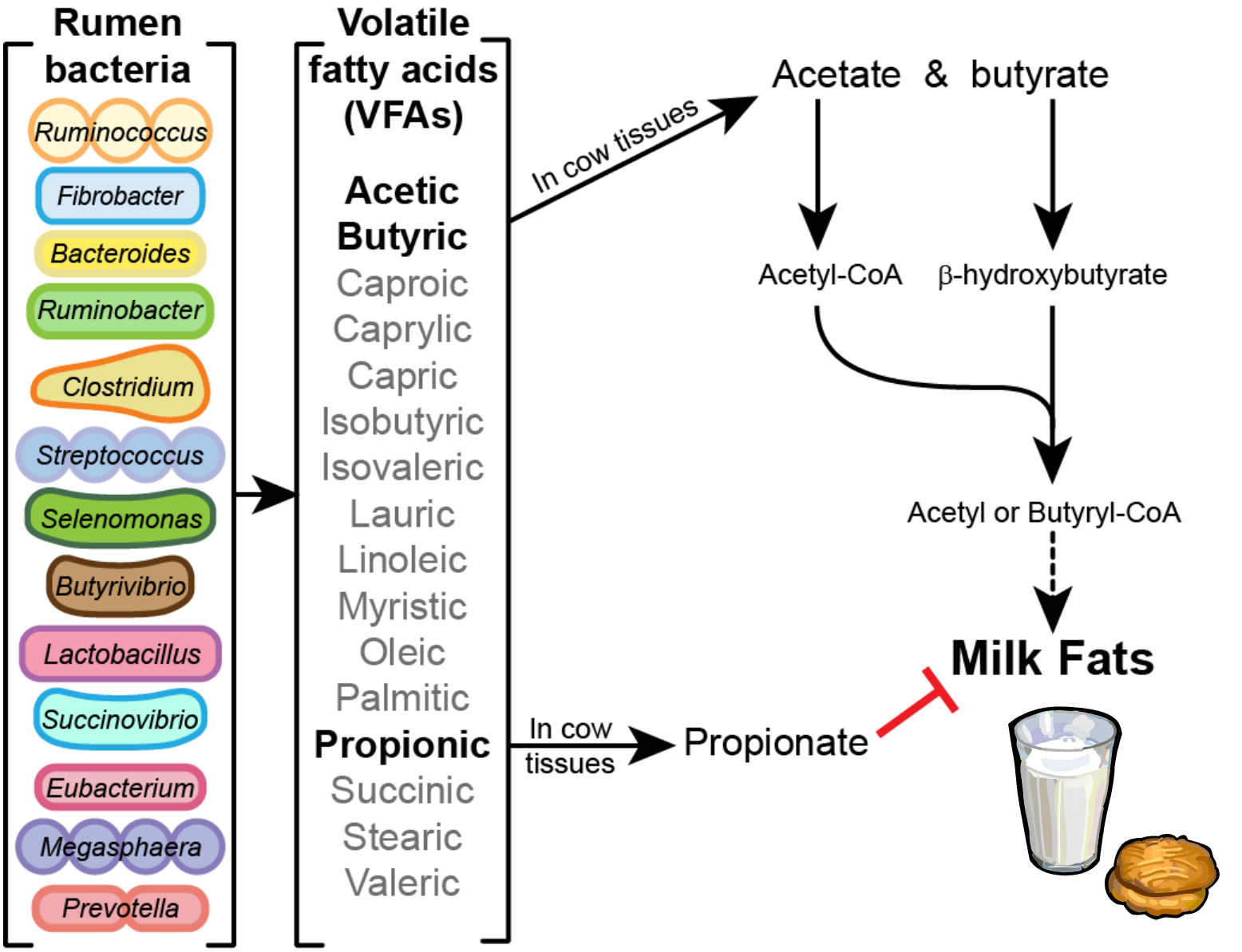


How does the rumen function?



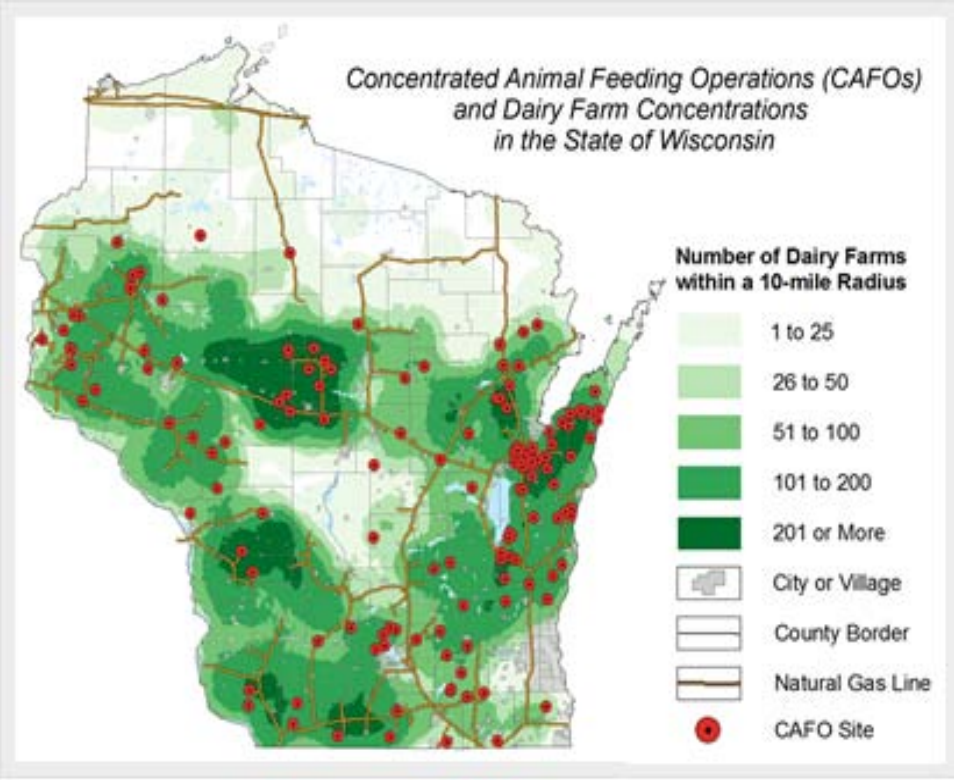
Dehority 2003 Rumen Microbiology, Flint 2008 *Nature Rev Microbiol,* Cheng 2009 *Bioresource Tech*

Milk production depends on microbes



Milk pathway vastly simplified from: B. Larson & V. Smith "Lactation: A comprehensive Treatise" Vol. II 1974

On Wisconsin



Feed is expensive

Farmers are switching from calf starter to other feeds

Unknown what effects other feeds have on milk production

How does diet affect calf development, ruminal microbiome acquisition, and milk production efficiency?

- Calf Development
  - Average Daily Weight Gain
- Ruminal Microbiome Acquisition
  - Bacteria, Archaea, Fungi
- Milk Production Efficiency
  - Energy Corrected Milk / Dry Matter Intake

Kim Dill-McFarland

Study Design

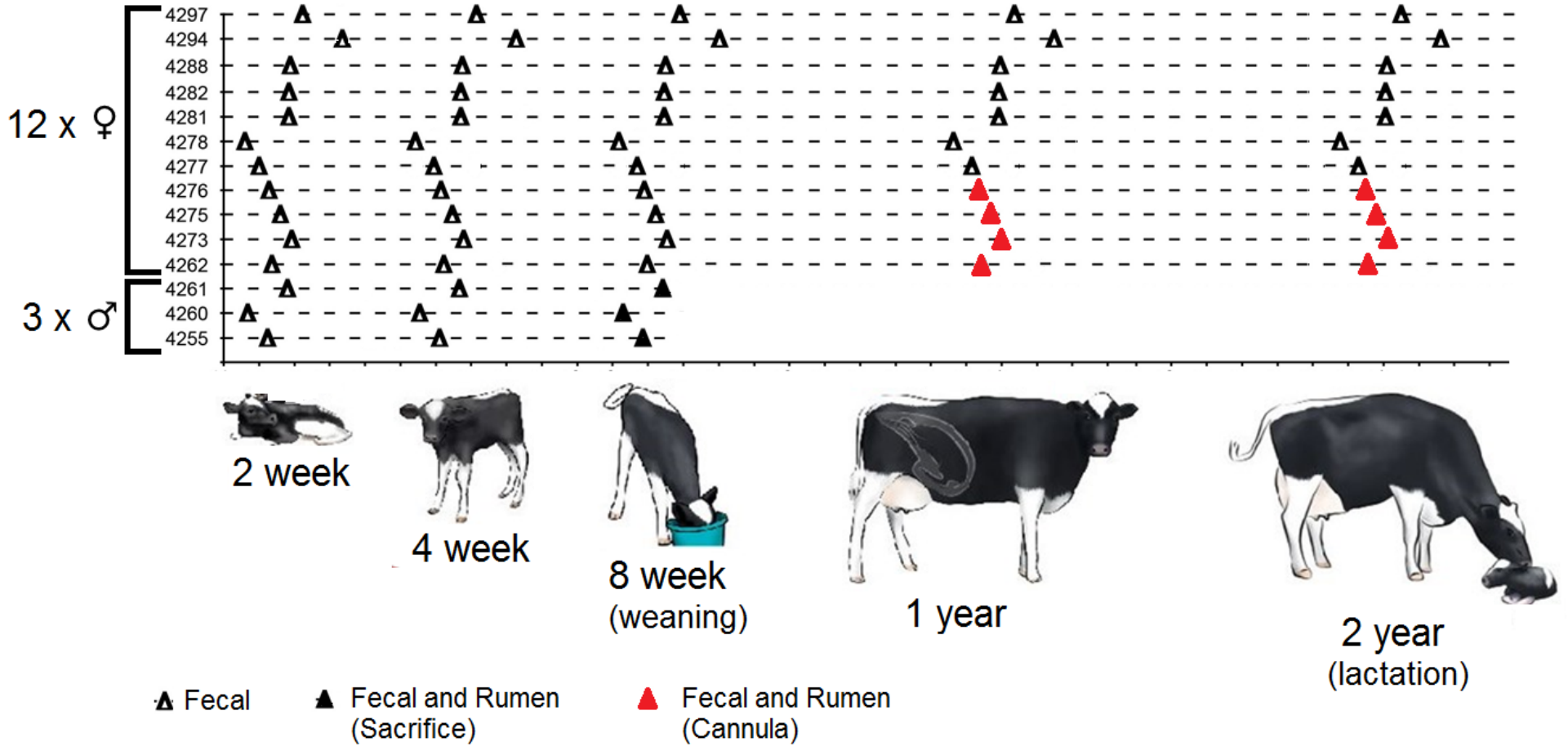
- 3X cohorts of 12 female + 3 male Holstein calves
- Raised on pasteurized milk with balancer +
  - Ampli-Calf starter grains (low fiber)
  - Corn silage (high fiber)
  - 50/50 mixture

Calf starter

Corn silage

www.iowacornstalk.com
www.whiteoakmills.com

Sampling



All animals were born in the same period and fed one of 3 diets until weaning

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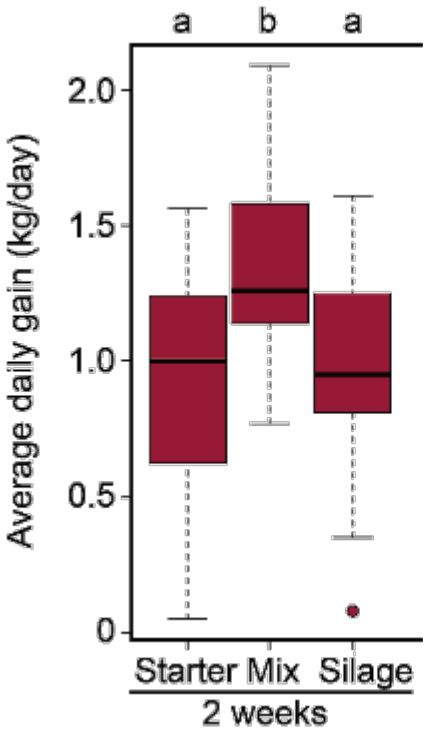
Animal Development



- Silage does not adversely affect Average Daily Gain

Dill-McFarland *et al*. 2016 ISME J. In prep.

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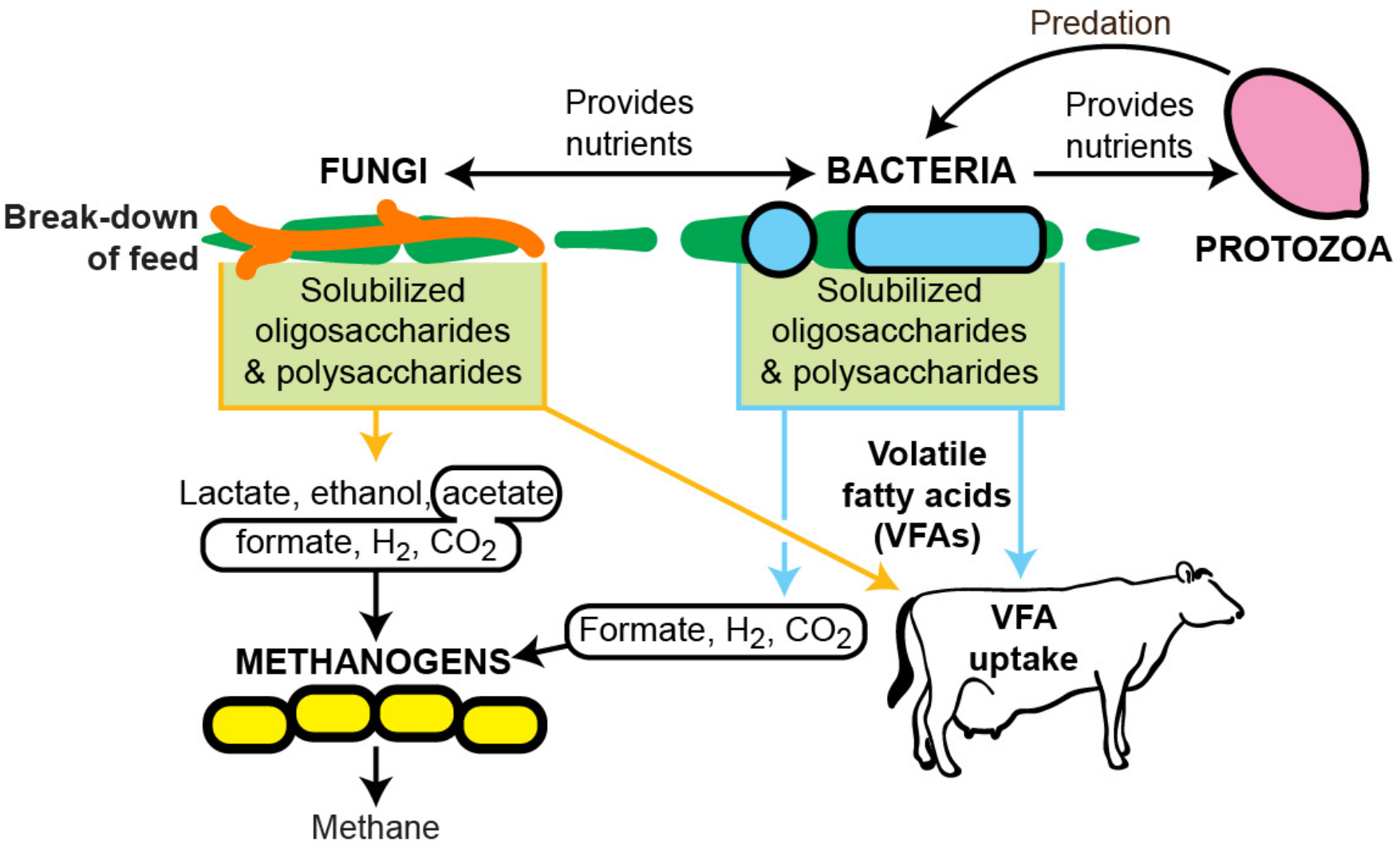

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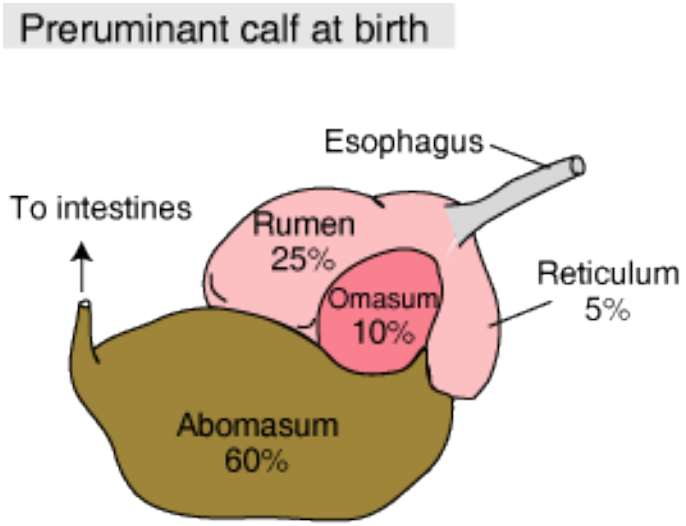
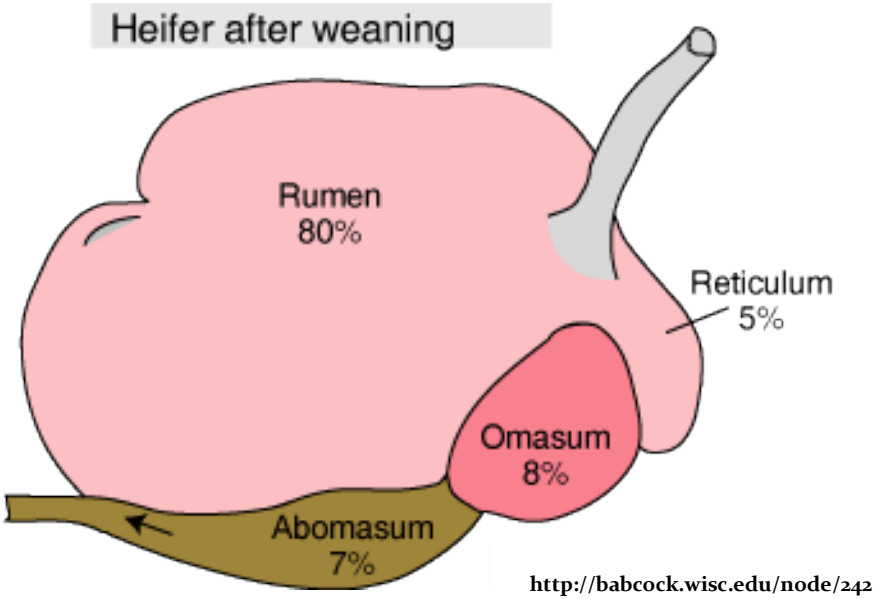
Calves do not have a functional rumen





http://babcock.wisc.edu/node/242

http://aorakistockfoods.co.nz/extra_info.html

Anderson, Nagaraja, Morrill.1987; Guilloteau, Zabielski, Blum.2008

Measuring Microbial Communities

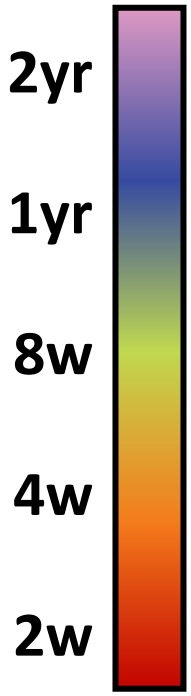
Illumina MiSeq Sequencing

- Bacteria: V4 16S rRNA
- Archaea: V6-V8 16S rRNA
- Fungi: ITS

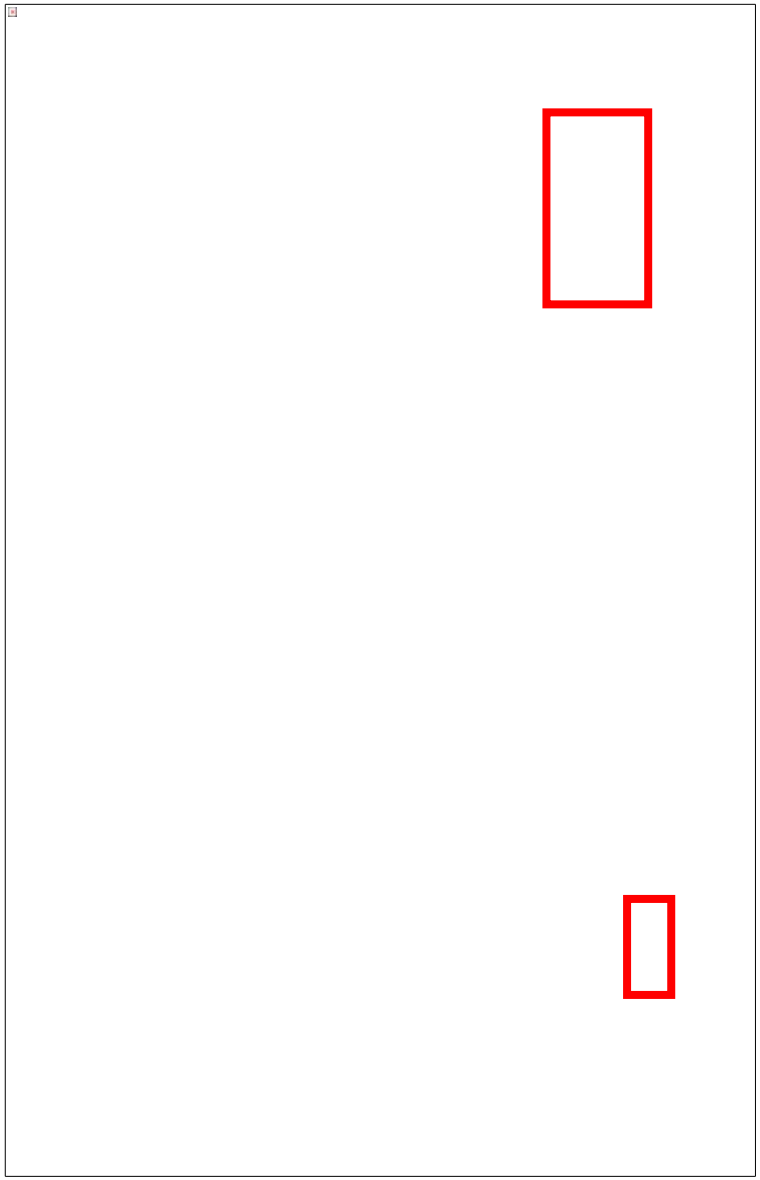
<u>358 samples from 45 animals</u>

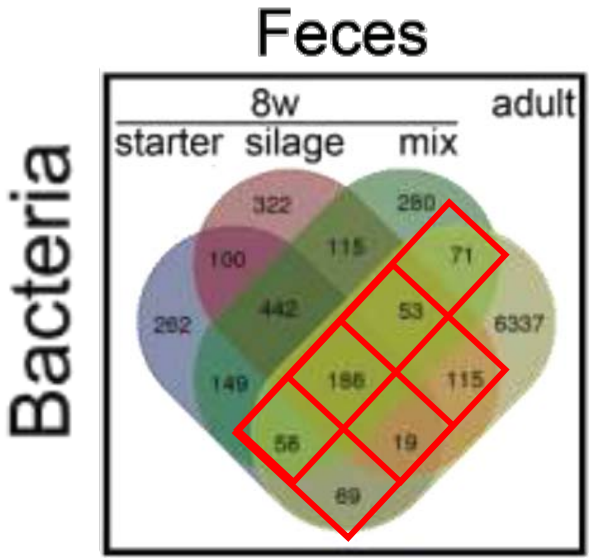
Bacteria:	13.9 million (mean 39,000 / sample)
Fungi:	5.3 million (mean 23,000)
Archaea:	540,000 (mean 1,500)

Short- and long-term effects of calf diet



● starter grains
□ mix
▲ silage





Shared Taxa

- Starter = 331
- Silage = 373
- Mix = 368

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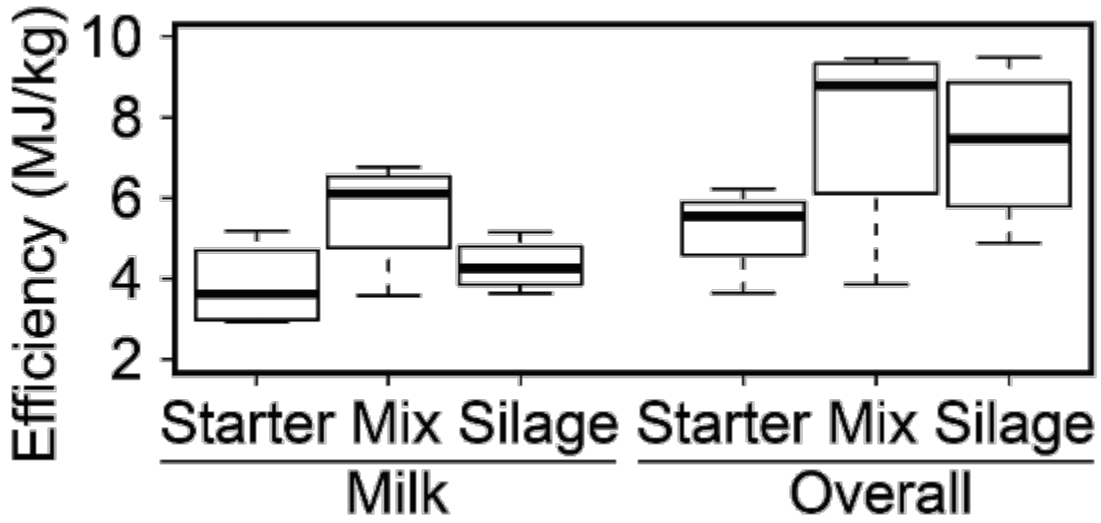
Milk Production Efficiency



- Milk = Total Milk Production / Dry Matter Intake
- Overall = Energy Corrected Milk / Dry Matter Intake

- Silage does not affect milk production
- Silage and the Mix result in small gains

Conclusions

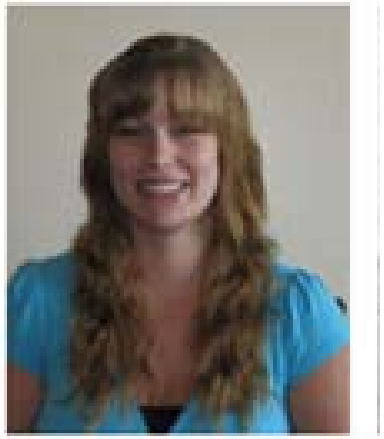
- Corn Silage and the Mix Diet does not adversely affect average daily gain
- Corn Silage and the Mix Diet promote faster development to an “adult-like” ruminal microbiome
- Both Diets increase milk production efficiency relative to calf starter fed animals

Switching to Corn Silage or a Mix does not affect overall calf development

Future Directions

- Test other diets (other silages?)
- Increase animal size to gain stronger statistical power
- Metagenomics to determine what the microbes are doing

Acknowledgements



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Paul Weimer

USDA Dairy Forage Research Center

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