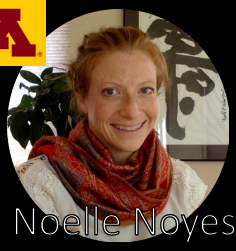
The microbiome: what is it, and how might it impact organic dairy production?

openROAMER Project Team

openROAMER faculty researchers


Brad Heins


Luciano Caixeta


Noelle Noyes


Pablo Pinedo


Vinicius Machado

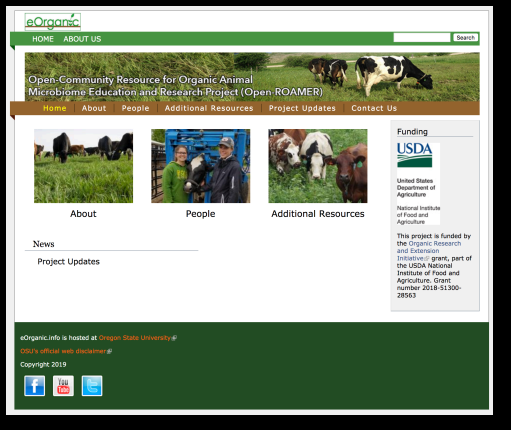

Alice Formiga

And many, many students and post-doctoral researchers

Catalyzing an open-community research and education program to leverage the microbiome for the advancement of organic livestock production, using mastitis as a test case

USDA Grant Number: 2018-51300-28563

Website: eorganic.info/openroamer



Plan for today:

High-level overview of the microbiome

Key microbiome concepts and translation to dairy production

The challenge of applied microbiome research

What might the future bring?

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Why the microbiome?

Hypothesis: The microbiome is crucial for dairy cow health and production

So what *is* the microbiome?

"the invisible universe in, on and around us"

https://www.youtube.com/watch?v=5DTrENdWvvM

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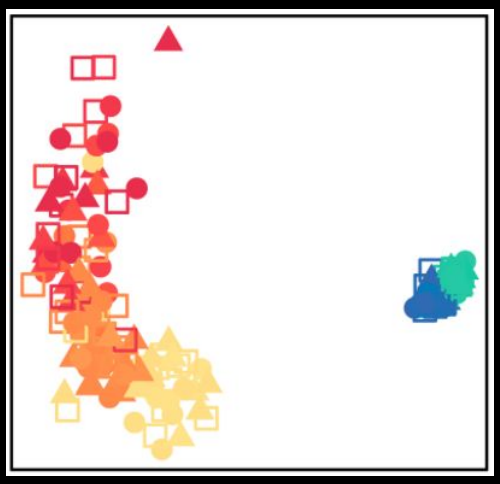
Some important points:

1. The microbiome changes with age/development

Microbiome changes with age:



RED = 1 week of age

ORANGE = 4 weeks of age

YELLOW = 8 weeks of age

GREEN = 1 year of age

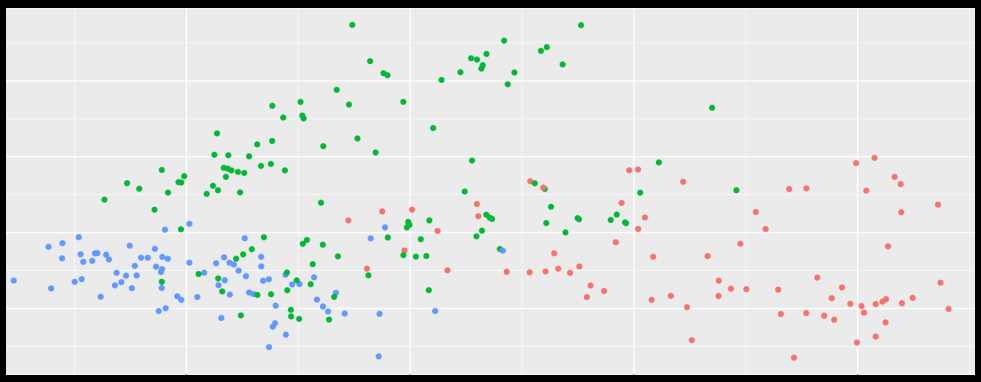
BLUE = 2 years of age

Influences Early Microbiota Development in Dairy Calves without Long-Term Impacts on Milk Production
Kimberly A. Dill-McFarland, Paul J. Weimer, Jacob D. Breaker, Garret Suen

Some important points:

1. The microbiome changes with age/development
2. Each person/animal/farm has a unique microbiome "fingerprint"

Unique microbiome fingerprints:



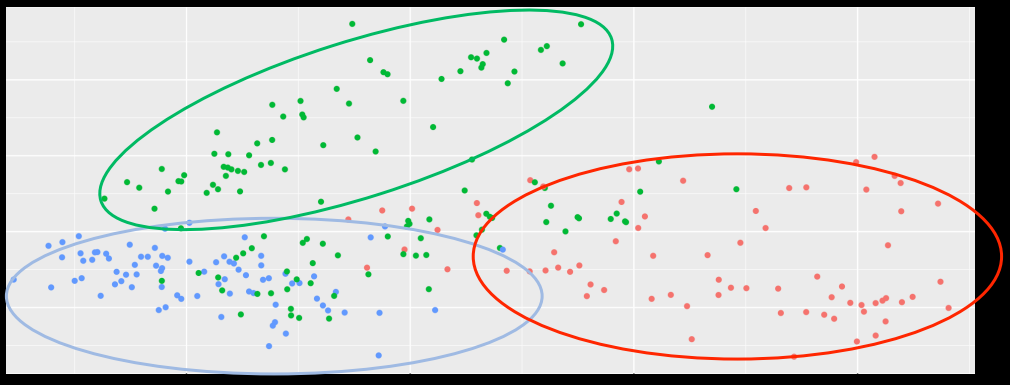
RED = FARM 1

GREEN = FARM 2

BLUE = FARM 3

Preliminary Data

Unique microbiome fingerprints:



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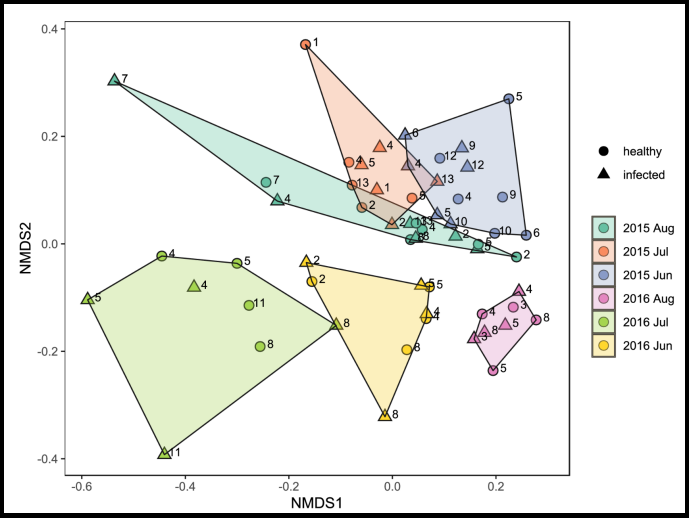
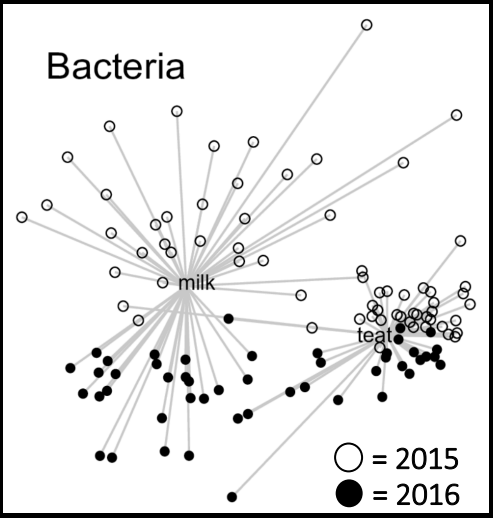
Preliminary Data

However, “time” or “sampling day” were major drivers of the microbiome…



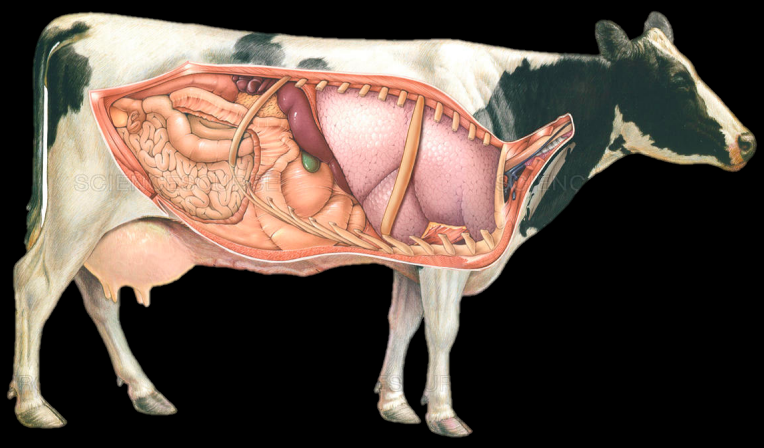


Andrews T, Neher DA, Weicht TR, Barlow JW (2019) Mammary microbiome of lactating organic dairy cows varies by time, tissue site, and infection status. PLoS ONE 14(11): e0225001. https://doi.org/10.1371/journal.pone.0225001

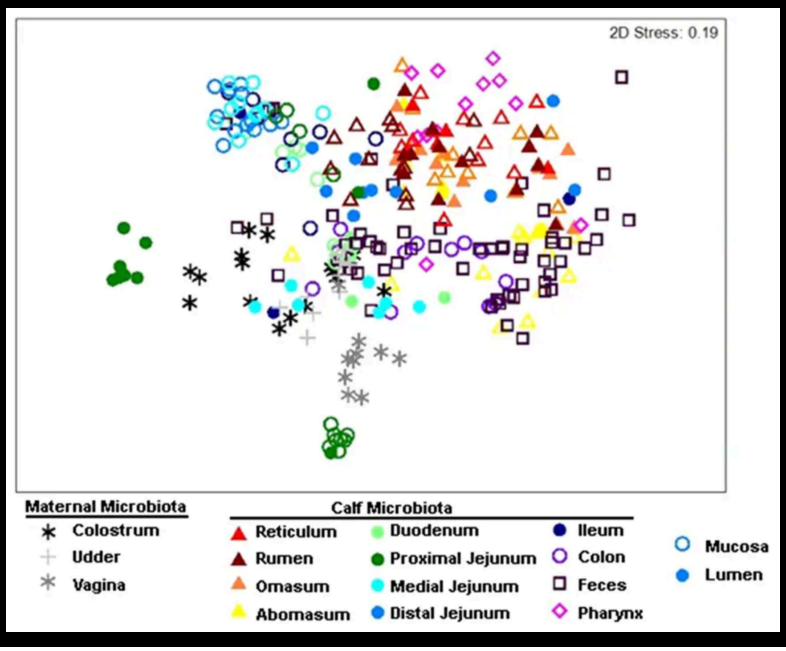
Some important points:

1. The microbiome changes with age/development
2. Each person/animal has a unique microbiome “fingerprint”
3. Within an animal, there are different microbiome ecosystems

The many microbiomes of the lactating dairy cow



The many microbiomes of the dairy cow:

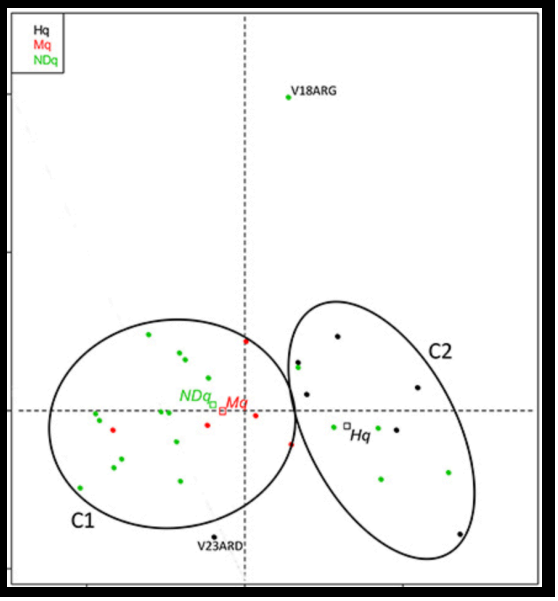


Yeoman, C.J., Ishaq, S.L., Bichi, E. *et al.* Biogeographical Differences in the Influence of Maternal Microbial Sources on the Early Successional Development of the Bovine Neonatal Gastrointestinal tract. *Sci Rep* **8,** 3197 (2018). https://doi.org/10.1038/s41598-018-21440-8

What about the mammary microbiome?

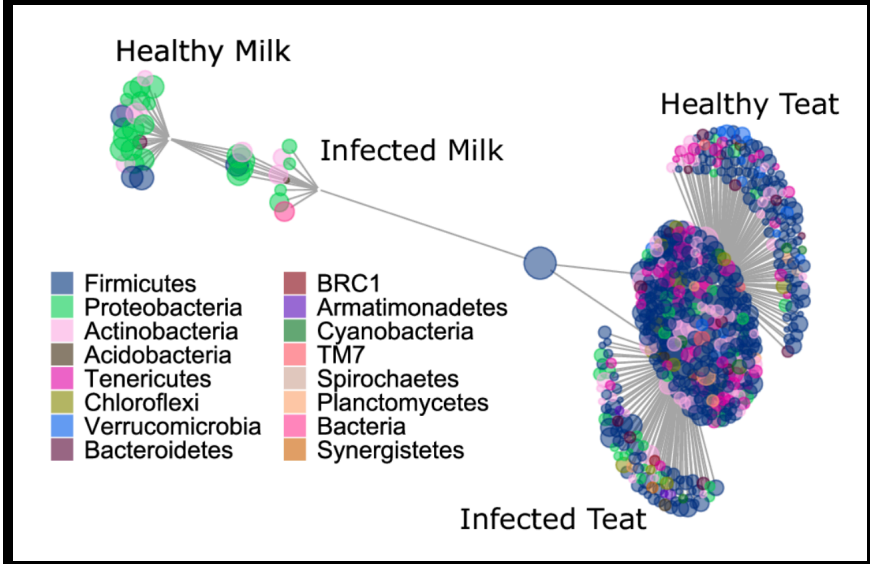
Evidence that the udder/mammary microbiome plays a role in mastitis…

The microbiome of quarters with and without a history of mastitis may be different…



Falentin H, Rault L, Nicolas A, et al. Bovine Teat Microbiome Analysis Revealed Reduced Alpha Diversity and Significant Changes in Taxonomic Profiles in Quarters with a History of Mastitis. *Front Microbiol*. 2016;7:480. Published 2016 Apr 8. doi:10.3389/fmicb.2016.00480

Milk and teat microbiomes differ somewhat between healthy and infected glands



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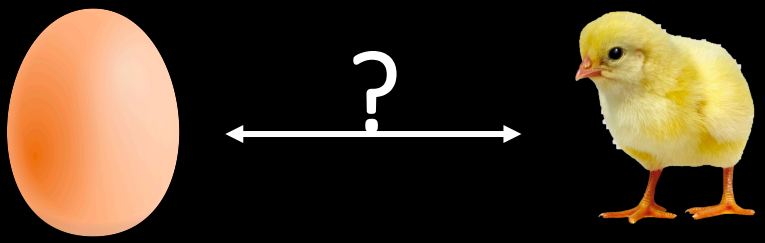
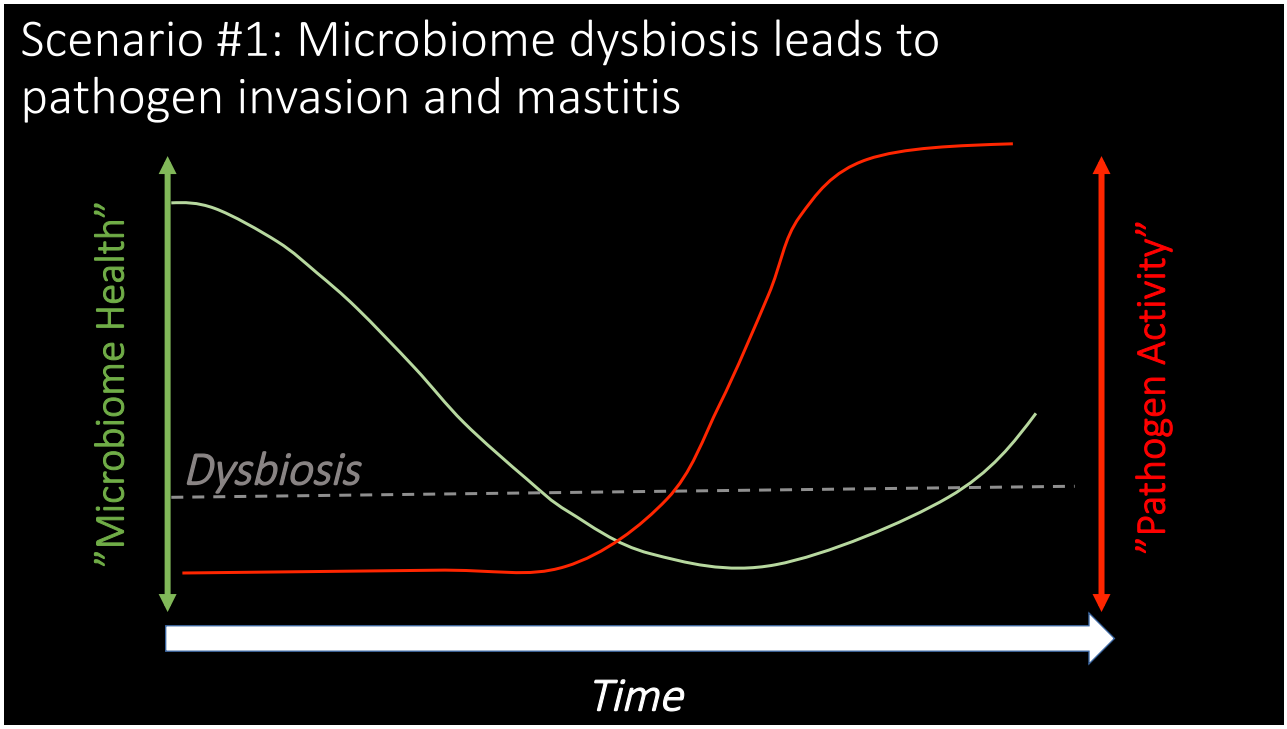
One major challenge: the chicken and the egg…

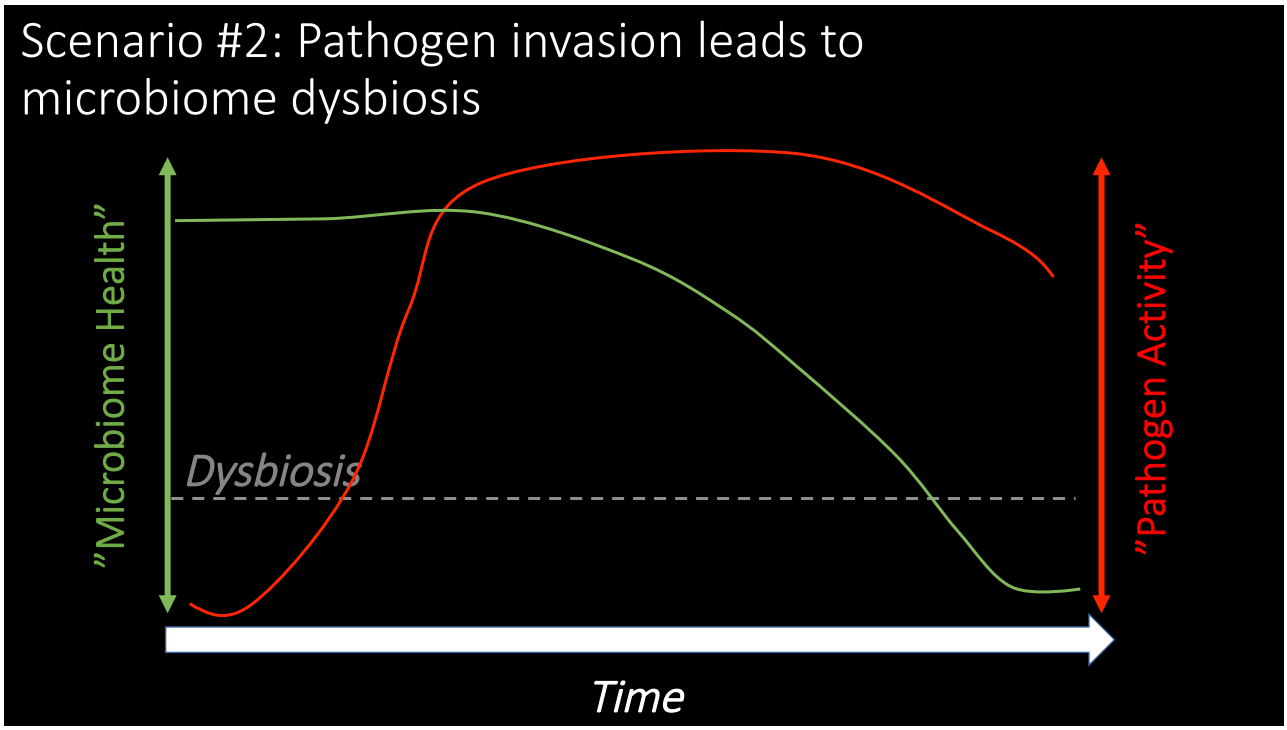


Microbiome ? Mastitis

Scenario #1: Microbiome dysbiosis leads to pathogen invasion and mastitis



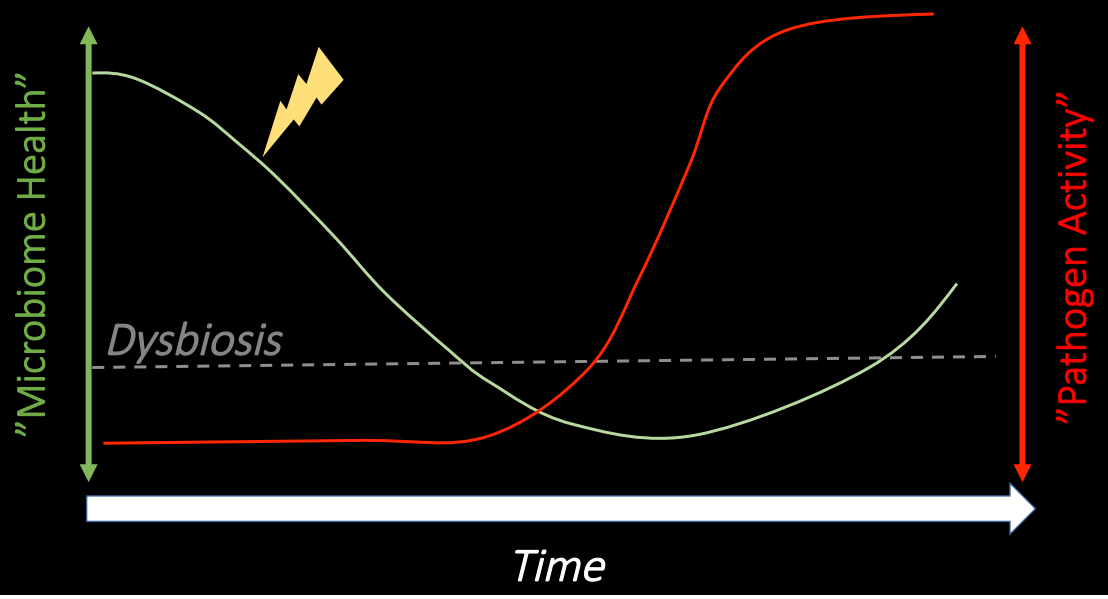
Scenario #2: Pathogen invasion leads to microbiome dysbiosis



Why does this matter?

The answers will dictate the efficacy, type and timing of microbiome-based interventions

For Scenario #1: supporting microbiome health before pathogen challenge may prevent mastitis from occurring



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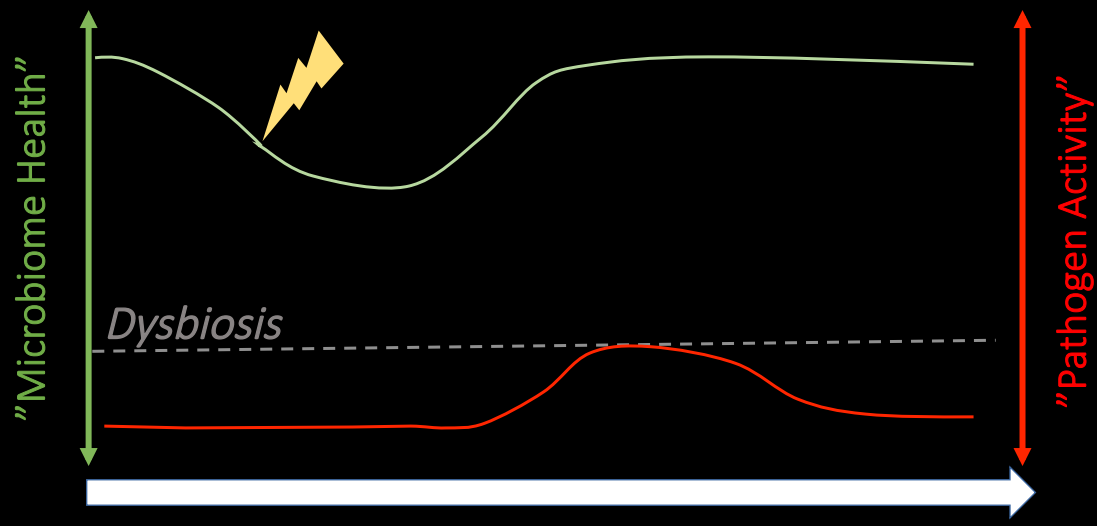
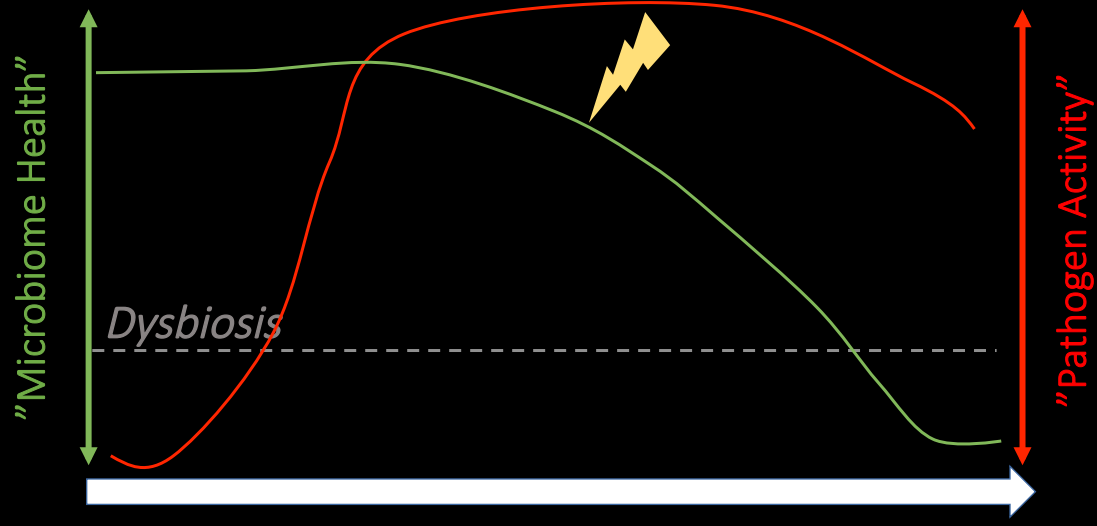


Scenario #2: pathogen invasion occurs regardless of microbiome, but perhaps we change disease course



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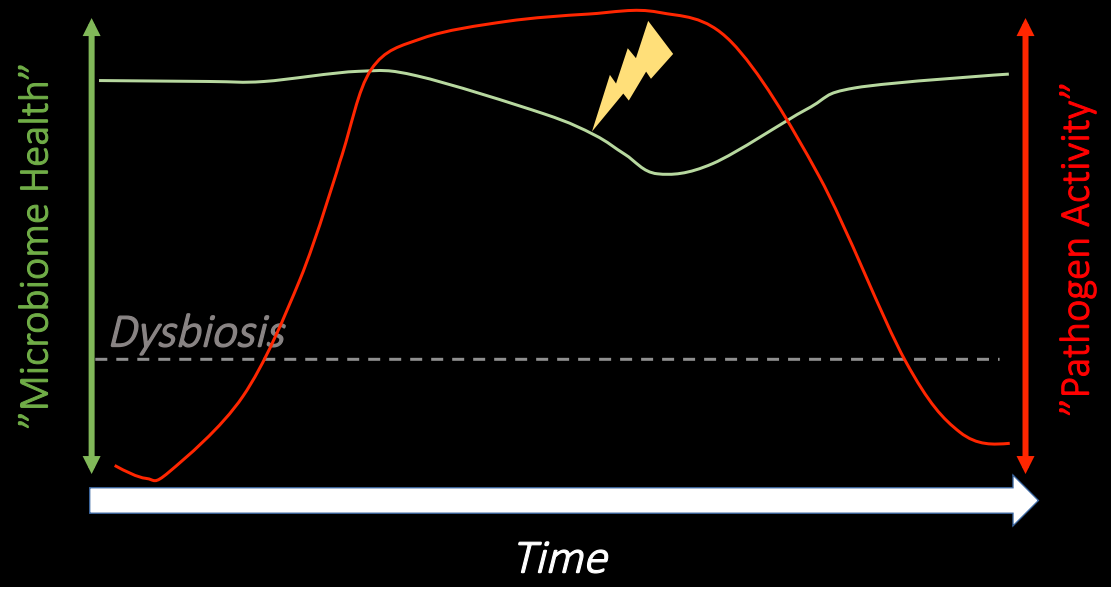

These types of details are really important, but really challenging to discover

And there are many other unanswered questions….

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The good news:

TONS of research being funded and conducted

LOTS of interest from farmers, producers, veterinarians and others

LOTS of untapped potential

How are are trying to help:

Time-series, intensive sampling to understand temporal dynamics *(stay tuned!)*

Identification of bacterial-derived compounds that may prevent/treat mastitis *(stay tuned!)*

Educational materials to generate support for robust microbiome research and ensure responsible application of microbiome-based discoveries *(this webinar! openROAMER website, etc…)*

Open-source data and research pipelines so that others can build on our efforts *(stay tuned!)*

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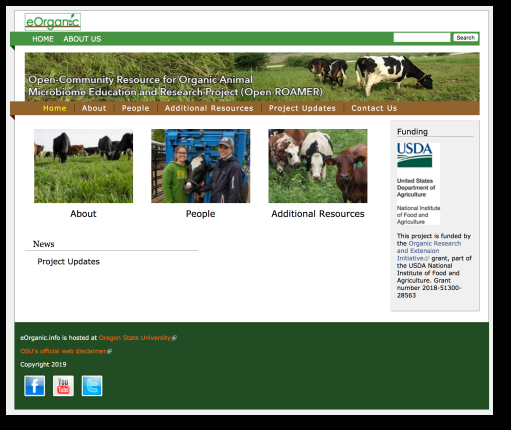
THANK YOU for your time!! And now, questions!!!



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