

Cattle genetics influences the abundance of ruminal pathogenic microbes

Rainer Roehe et al.

Rumen microbiome – a unique symbiotic system –

Feed (Forage)

Rumen capacity of a adult animal:
100 – 150 litres digesta

Can a healthier ruminal
microbiota be achieved through
breeding?

Bacteria

Fungi

Protozoa

↓
Fermentation

VFA
(Energy)

Microbes
(Protein)

Vitamins

10^{10} per g digesta

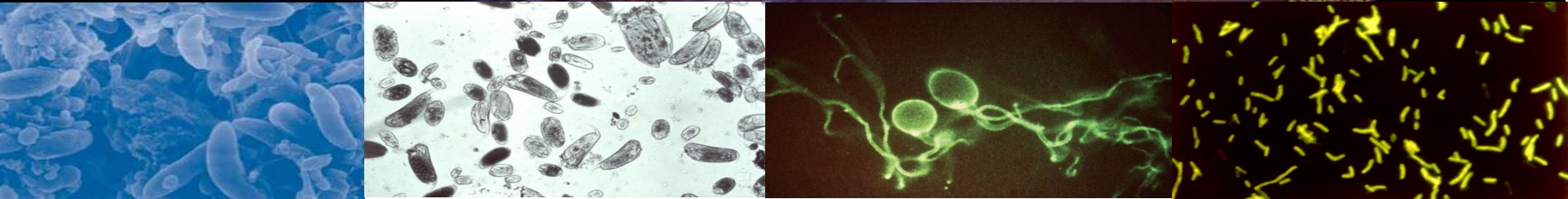
10^6 per g digesta

10^3 per g digesta

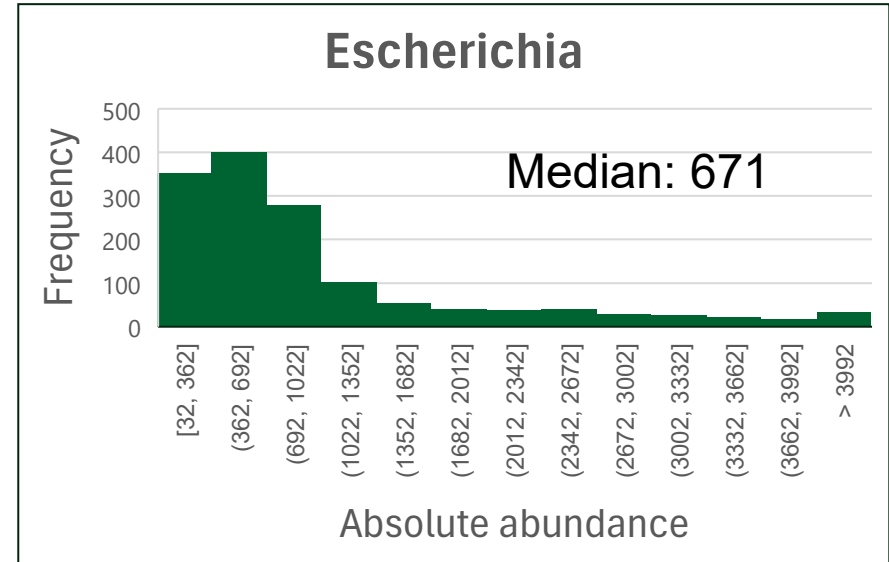
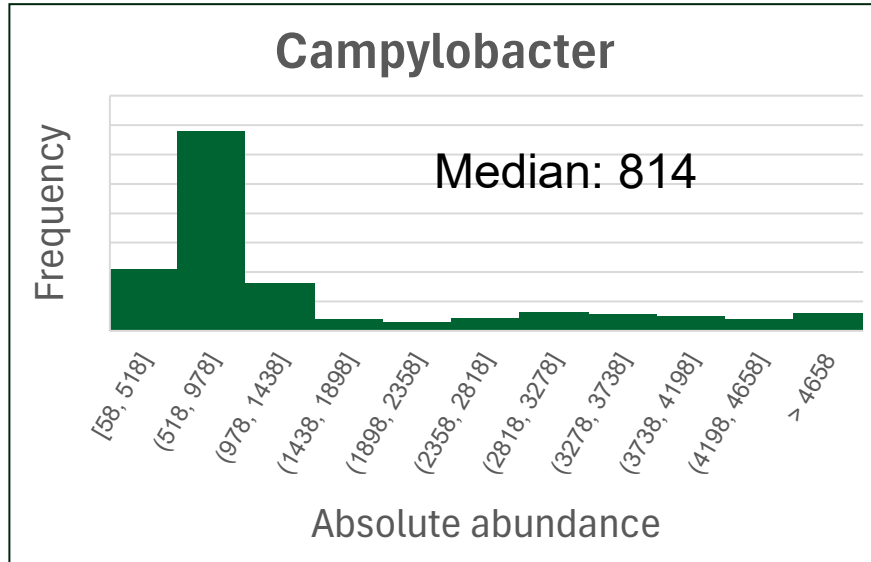
10^8 per g digesta

Objectives of the study

- Identifying the abundances of pathogenic bacteria in the rumen
- Are these abundances animal genomically influenced?
- Are these abundances genetically correlated with production traits?
- How could this information be used for breeding?

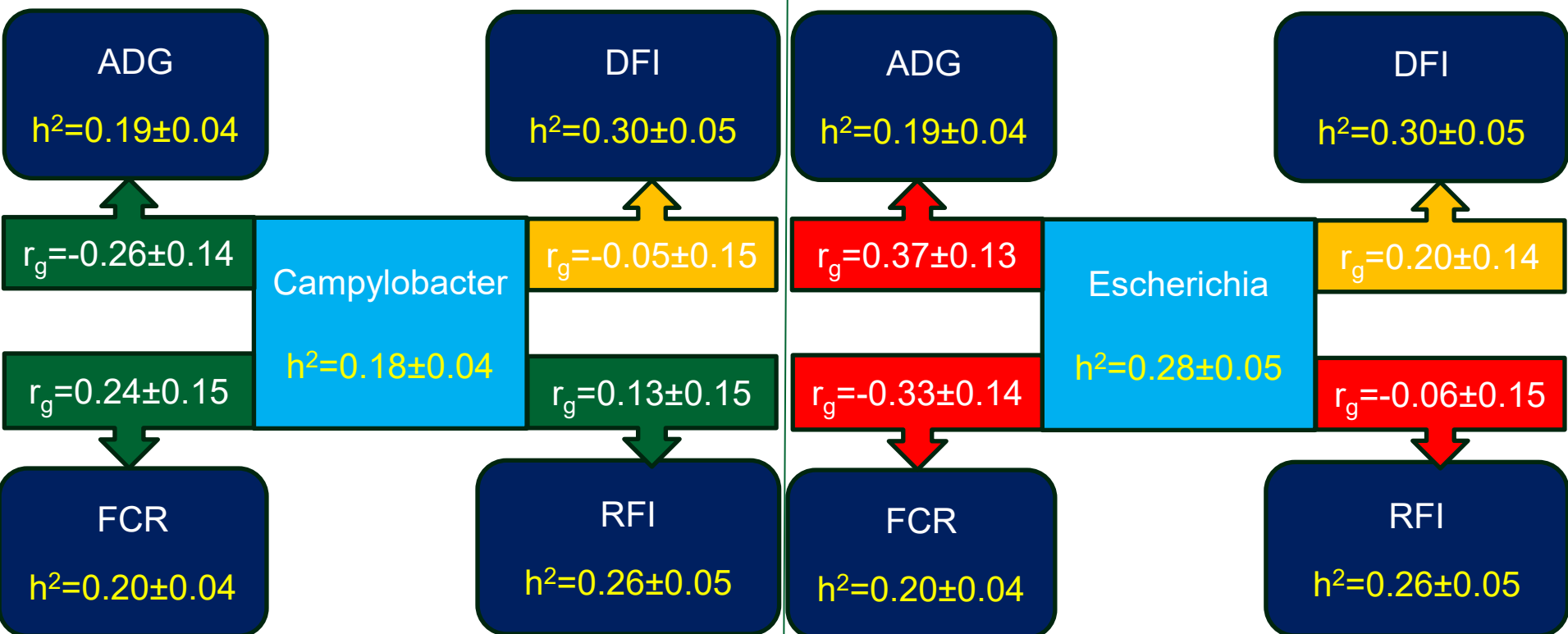


Absolute Abundances of some pathogens



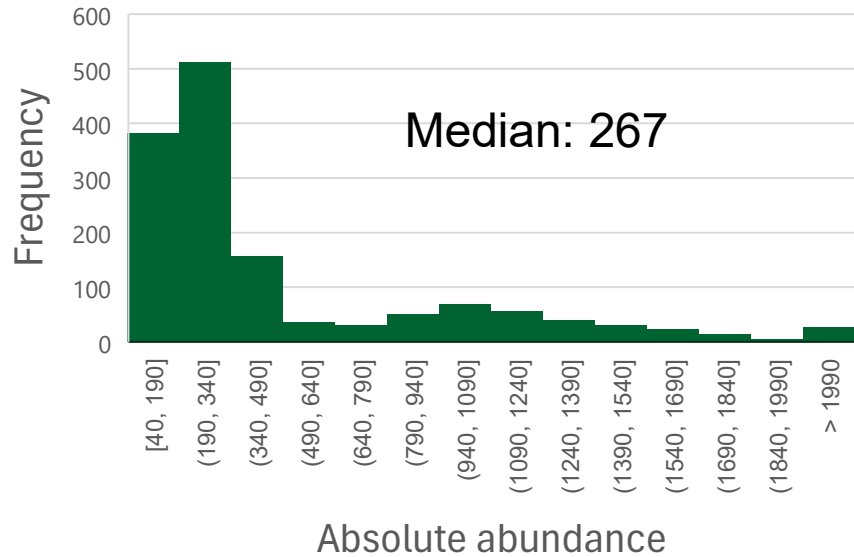
Heritability of abundances of pathogens and their genetic correlations with production traits

Data: 1,443 beef cattle; Genomics: 70k SNPs imputed; Microbiome: Whole metagenomics

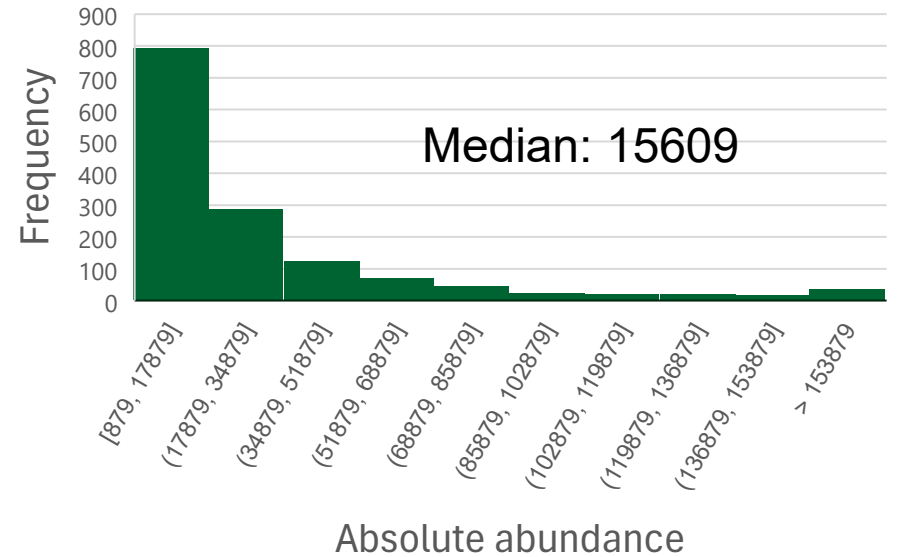


Absolute Abundances of some pathogens

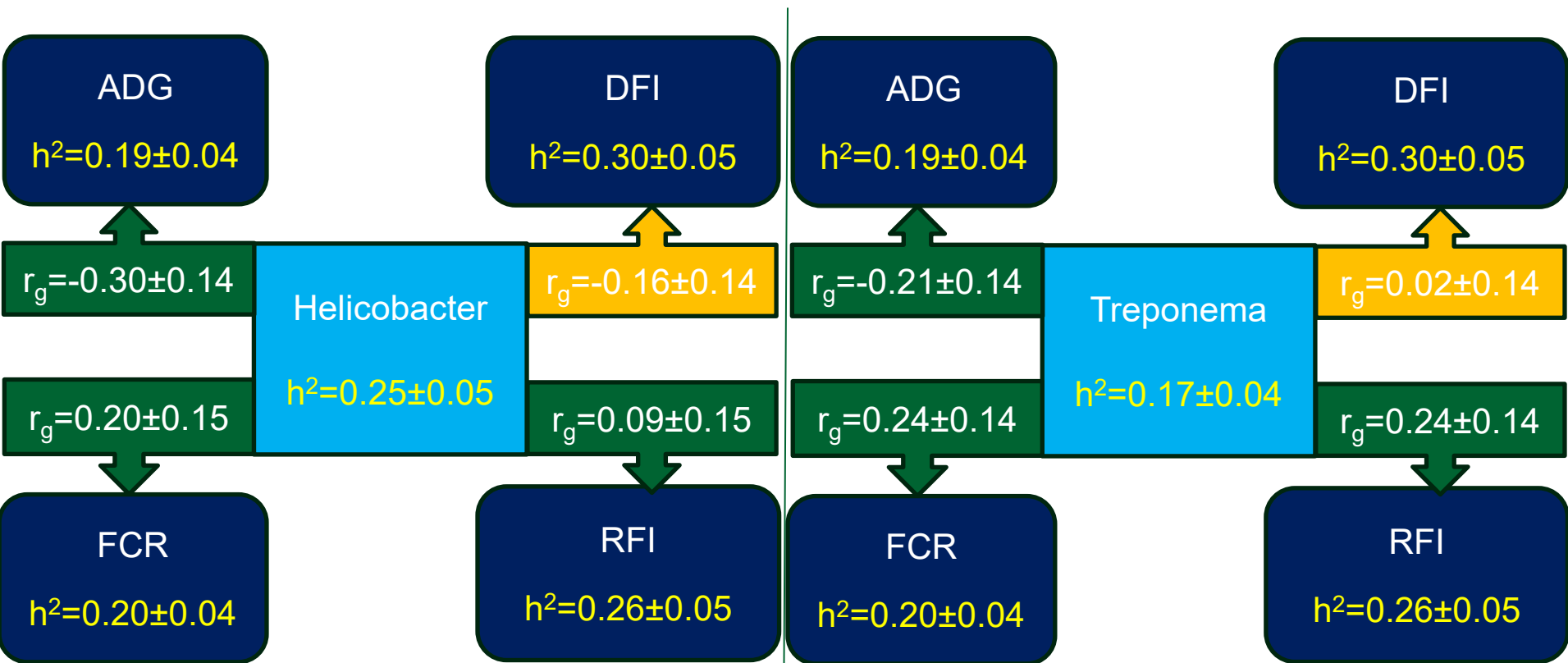
Helicobacter



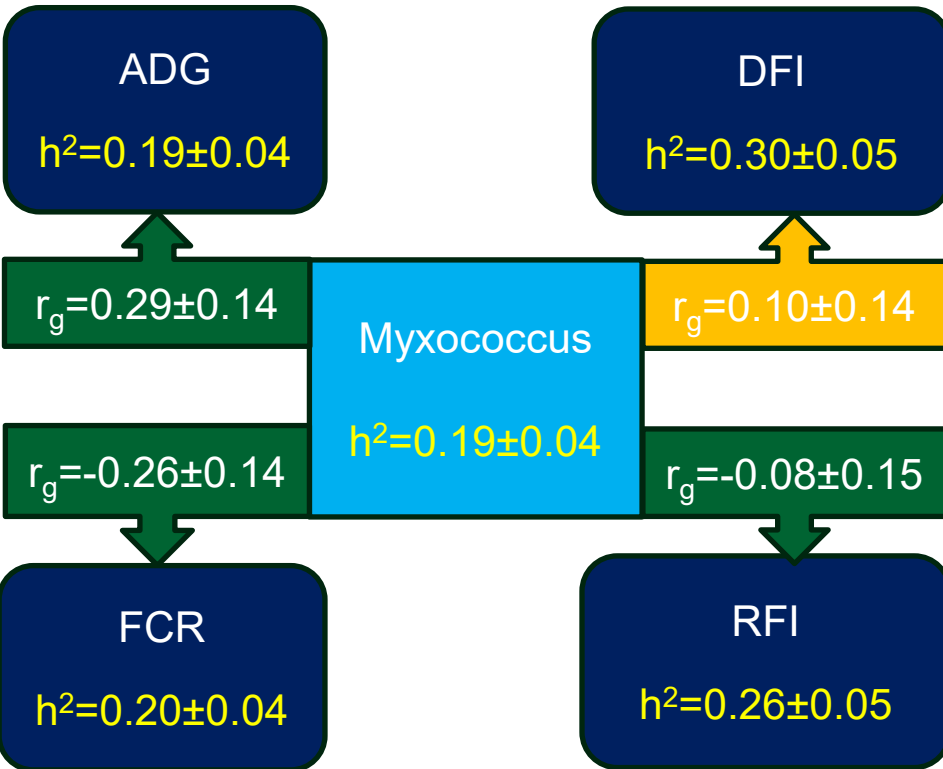
Treponema



Heritability of abundances of pathogens and their genetic correlations with production traits

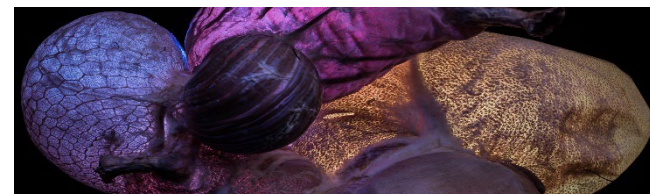
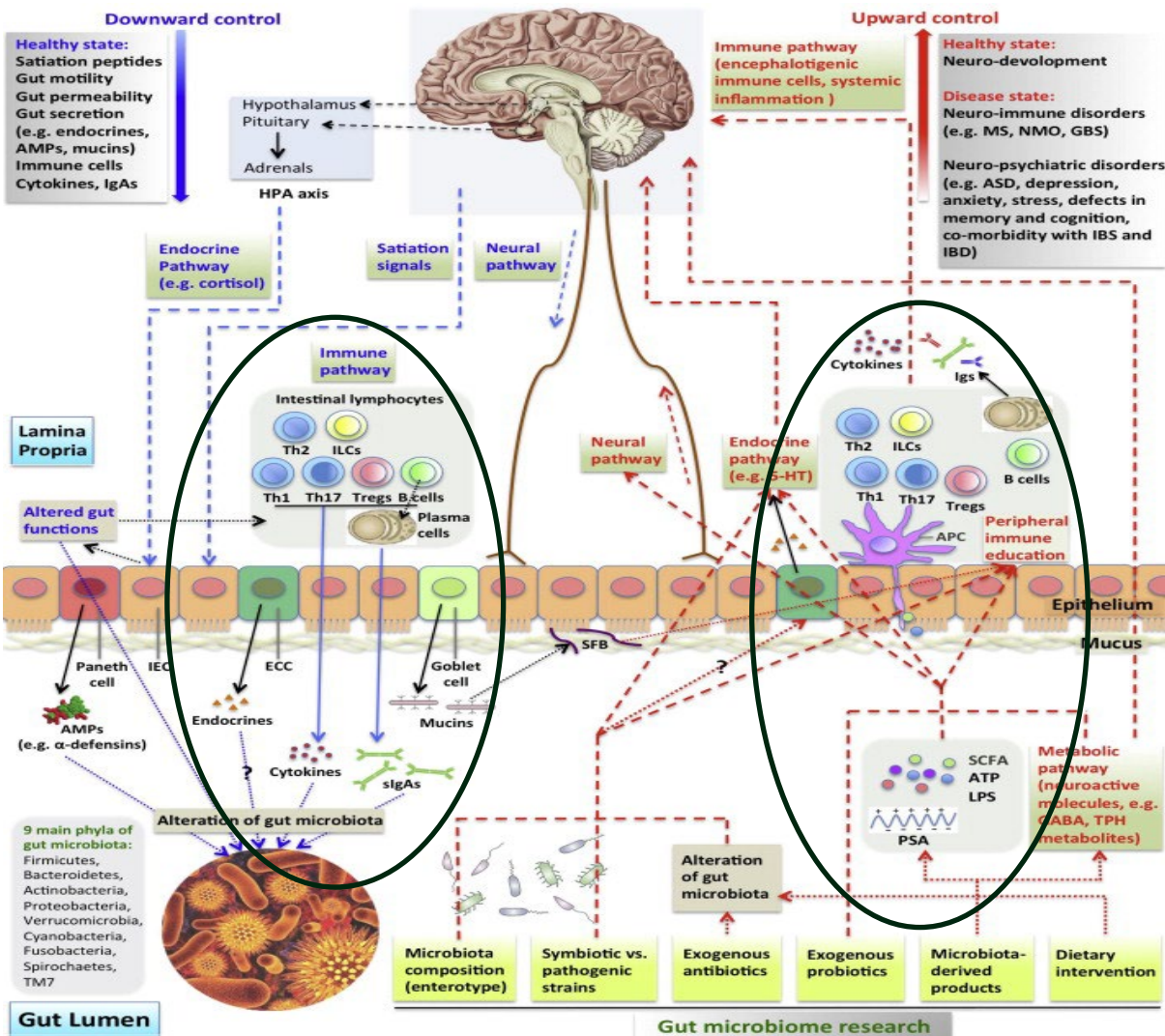


Heritability of abundances of a predator of pathogenic bacteria and its genetic correlations to production traits

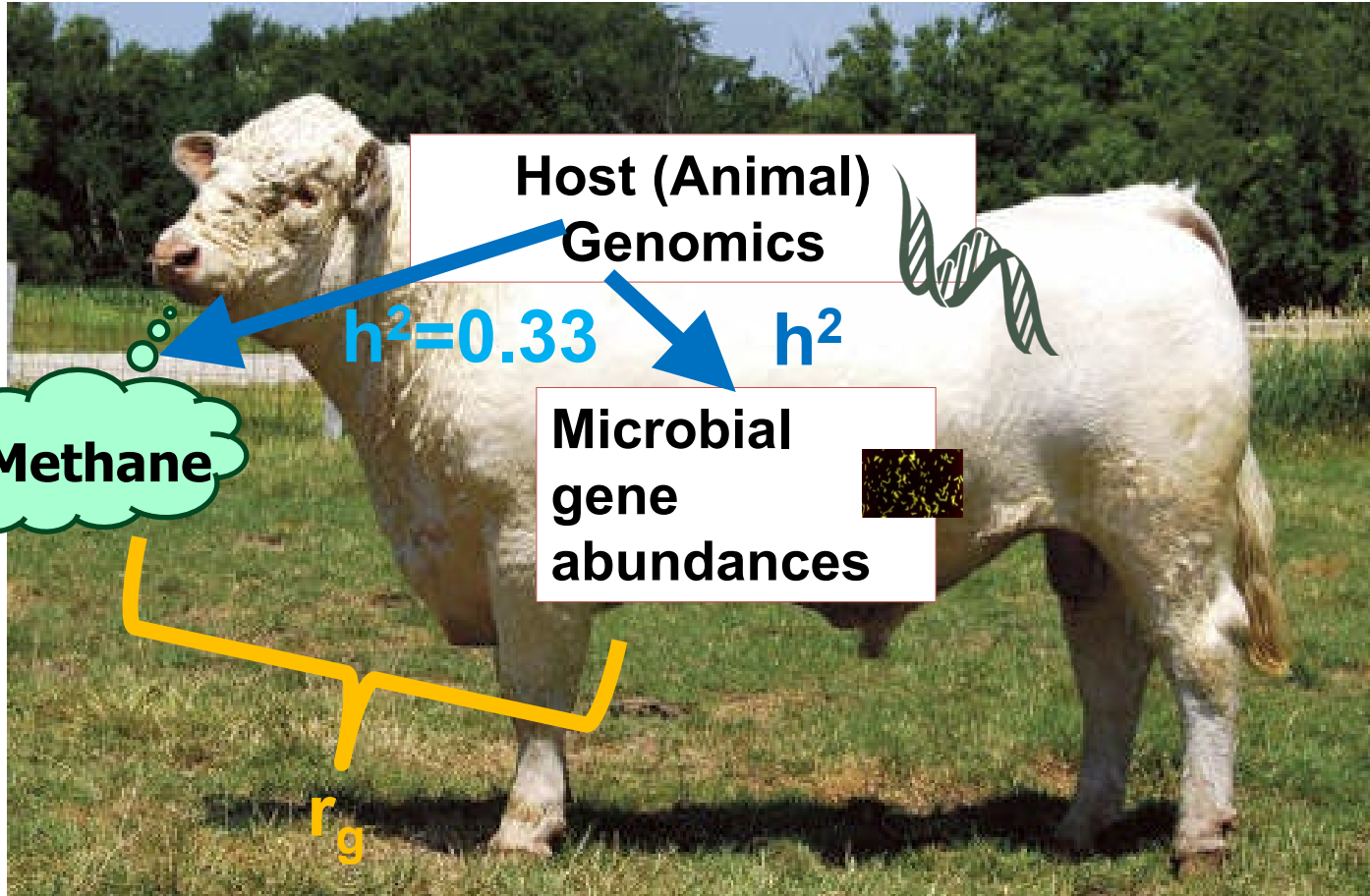


- Predator to other bacteria
- Large social behaviour to identify and lyse their prey
- In soil, contributes to nutrient cycling and important ecological impact on soil microbial communities.
- Median abundance of 737

Microbiome- Gut- Brain Axis



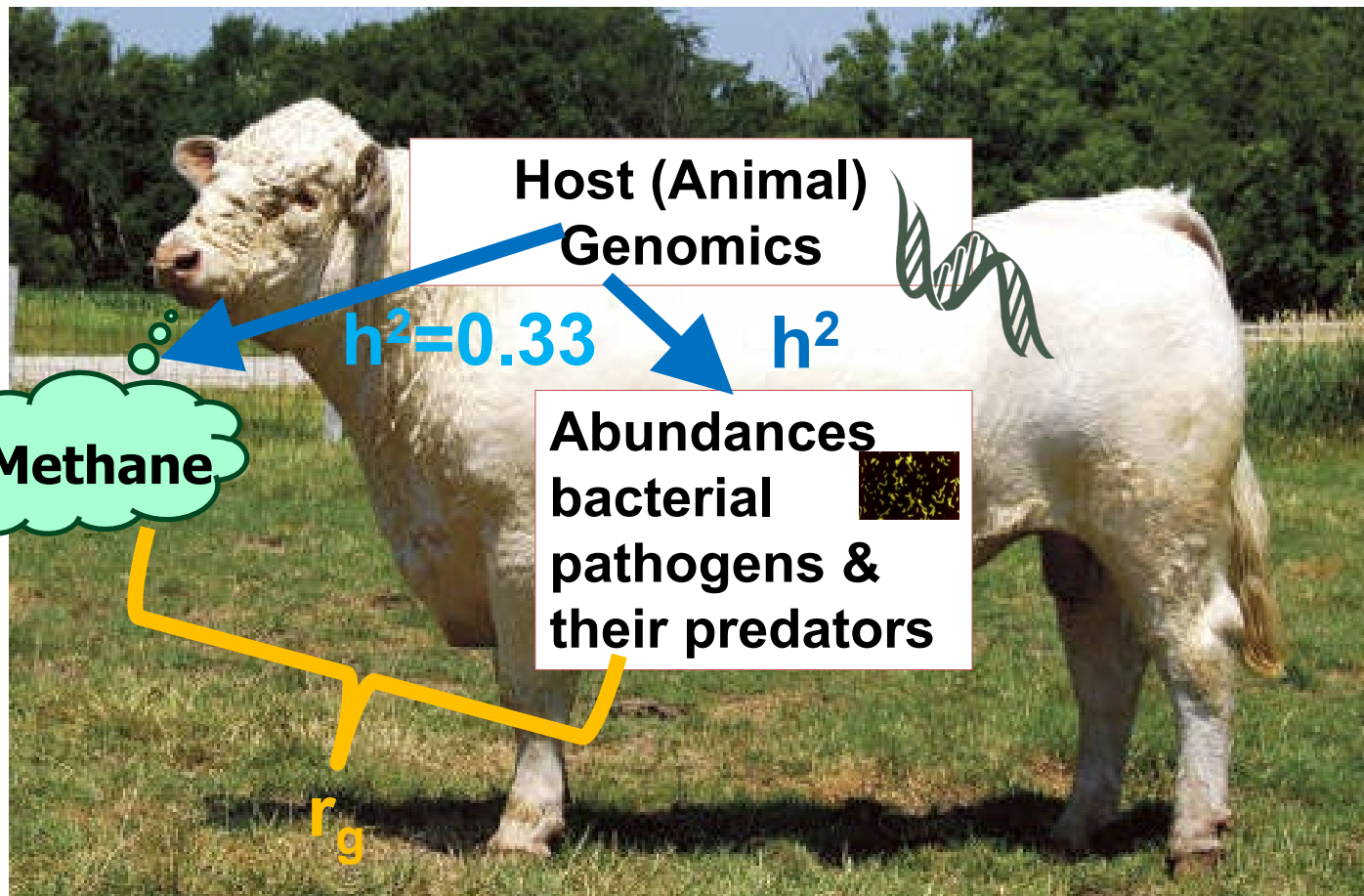
Using microbiome-driven breeding



70K SNPs

*Martinez-Alvaro et al.
2022
Commun. Biol.*

Using microbiome-driven breeding



70K SNPs

*Martinez-Alvaro et al.
2022
Commun. Biol.*

Use of microbiome-driven breeding

- **Breeding for reduced methane emissions**

*Martinez-Alvaro et al. 2022 Commun. Biol.; Auffret et al. 2018 Front. Microbiol. ,
Roehe et al. PLoS Genet. 2016*

- **Improvement of meat fatty acids profiles**

Martinez-Alvaro et al. 2022 Microbiome

- **Genetic enhancement of feed efficiency**

Martinez-Alvaro et al. 2022 WGALP; Lima et al. 2019 Front. Genet..;

- **Improvement of growth and its pattern**

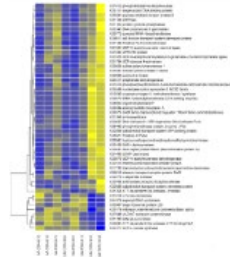
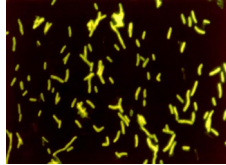
Martinez-Alvaro et al. 2024 GSE

- **Potential to reduce ruminal antimicrobial resistance**

Auffret et al. 2017 Microbiome

- **Use of metagenome-assembled genomes**

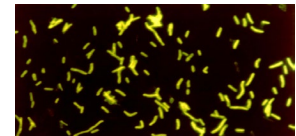
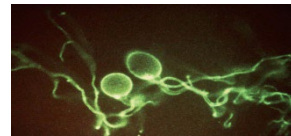
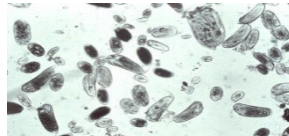
Stewart et al. 2019 Nature Biotechnology



Advantages microbiome-driven breeding

- **Cost-effective system to improve health, production, meat quality trait as well as reduce methane emissions**
 - Based on metagenomic information from one rumen sample
 - Stable core microbiome showed consistent predictability of methane emissions and production traits over the entire growing-finishing period

Lima et al. 2024, Scientific Reports (accepted)
- **Based on genetic and microbial functional information**
- **Addresses the underlying causes of ruminal pathogenicity and methane production**



Acknowledgements



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