Microbial ecology and probiotics to support animal nutrition

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Animal nutrition – past practices

- Main concern : improve feed efficiency and decrease pathogens load

- Antibiotics (AGP) were largely used to improve animal performance even though the mode of action not fully understood

More people, more demand for animal protein

But a more responsible animal production

Transition to the Ab free, less medication

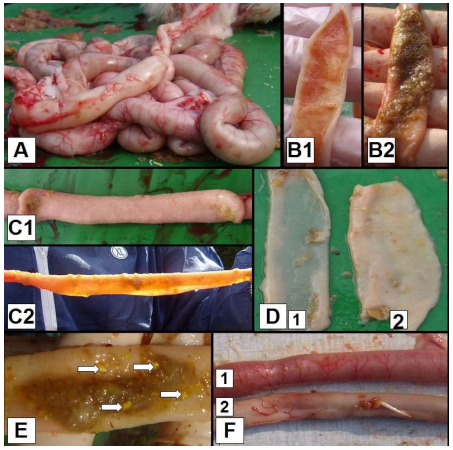
Produce a safe, qualitative, sustainable and afordable animal protein

Gut health is a main concern

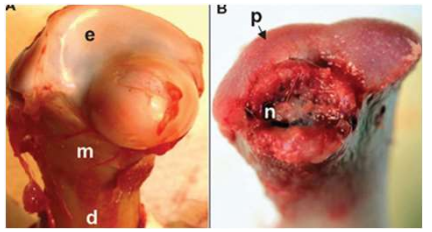
Poultry and pigs = athletes!
With boosted metabolism, High level of feed intake

Dysbiosis, leaky gut, inflammation

Wet litter,
undigested
feed particules



Intestinal inflammation /
leaky gut



Bacterial translocation
and systemic lesions

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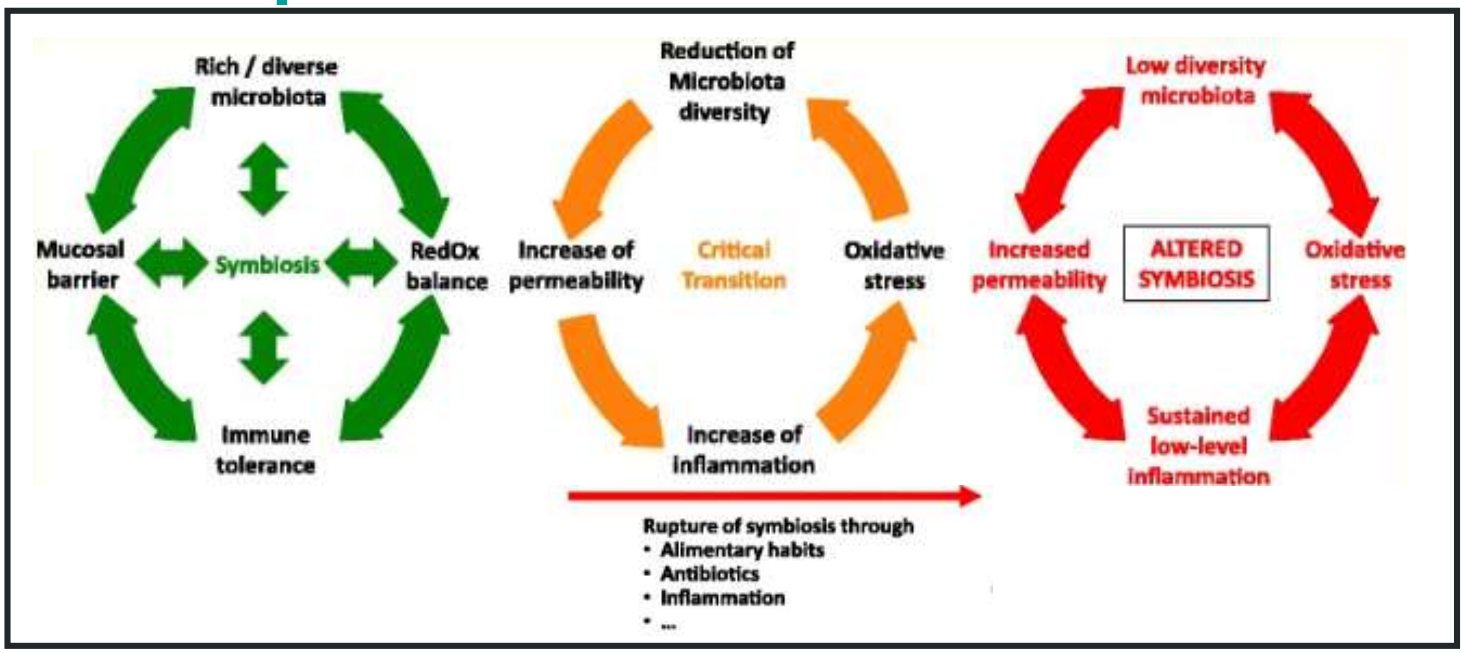
Digestive Health : The « Critical Transition » concept

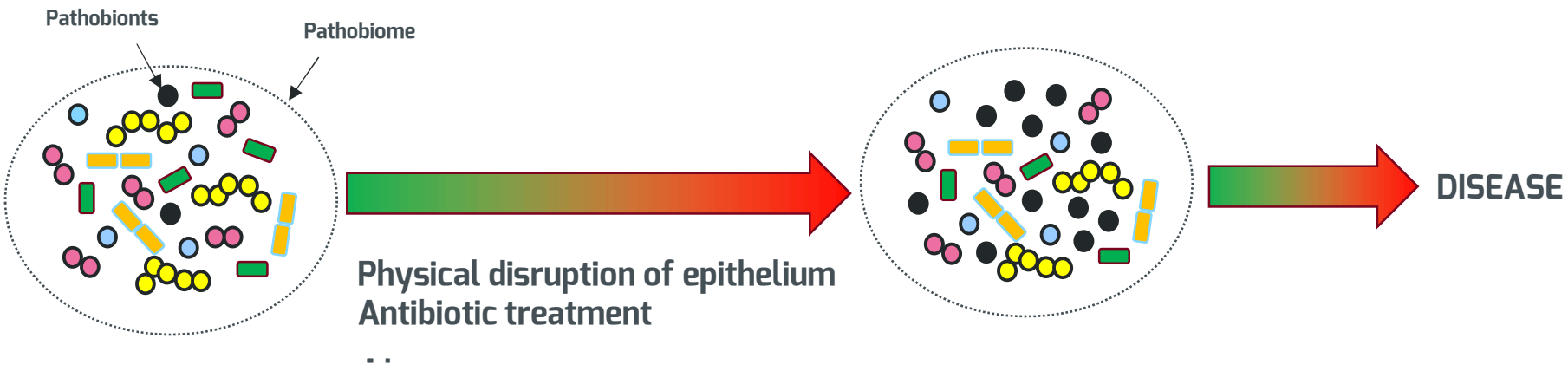


Van de Guchte et al. 2018

Microbiota is key to control inflammation, barrier integrity, RedOx balance

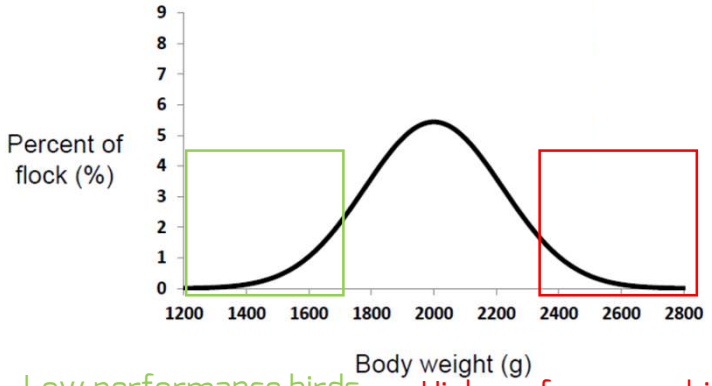
New role for animal nutritionists =
feeding the bugs as well as the bird !

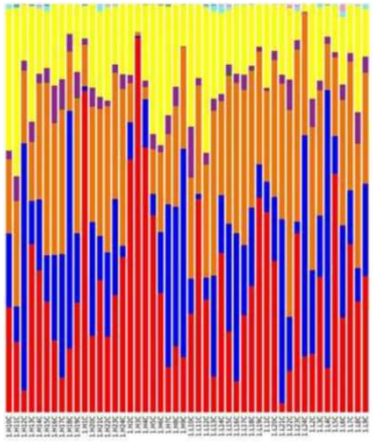
Intestinal microbial is also key when considering pathogens => ecological environmment



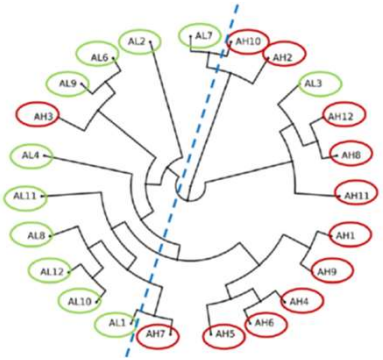
- Integrate « pathogens » in their microbial environment
- Maintain an optimal microbiota to control pathogen development => prevention by increasing resilience

Microbial signature for optimal Gut health: The idea is simple, the conclusion is not !





Relative proportions of each of the bacterial types identified (**DNA 16S sequencing**)



The overall microbiota composition of a bird can be scored, and then compared across a group to determine the relationship "microbiota ⇔ performance"

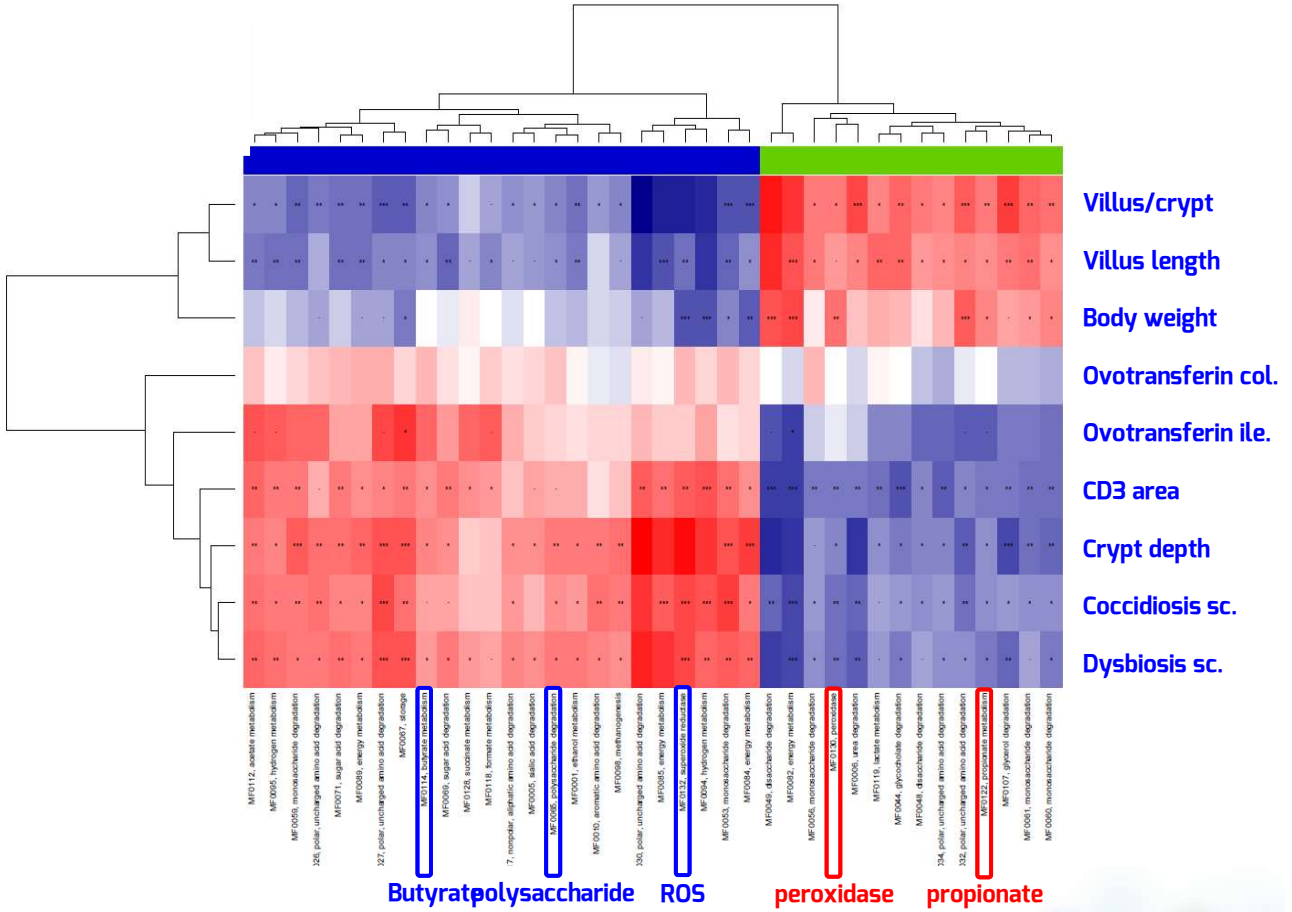
- Experiment repeated 3 times to confirm the results
- In each experiment, there were bacterial types whose abundance was correlated with performance
- **These performance associated bacteria varied from one trial to the next**

R. J. Moore, 2017 (RMIT Univ, Austalia)

Metagenomics : what are the microbial functions modified in dysbiosis challenge?

24 enriched modules in control group
Butyrate metabolism, polysaccharide degradation, and ROS reduction

14 enriched modules in challenge group
Lactate metabolism and peroxidase



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One way to improve animal production = probiotics

- Growth rate
- Feed efficiency and Nutrient Digestibility
- Carcass yield ; Egg production; milk production
- Animal product quality
- Gut health
- Control or prevention of enteric pathogens

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Main features of probiotics for animal production

SAFETY

- Non pathogenic
- Non toxic
- Not carrying antibiotic resistance

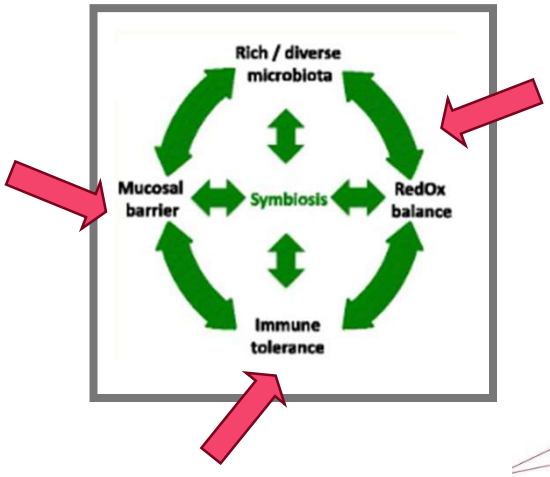
EFFICACY

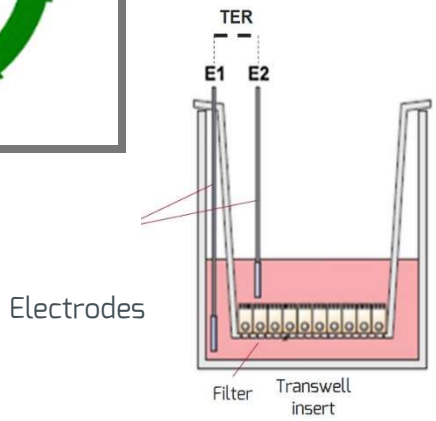
- Should survive in digestive tract
  - Acid conditions in stomach
  - Digestive enzymes
  - Bile salts
- **Should survive the feed processing**
- Should have a **beneficial effect** on host microbiota or/and host intestinal functions

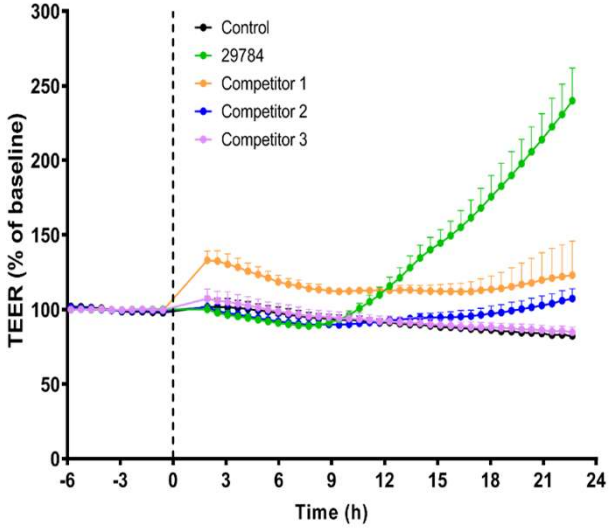
Feed processing is high constraint for the use of feed additives
- High heat
- High Pressure

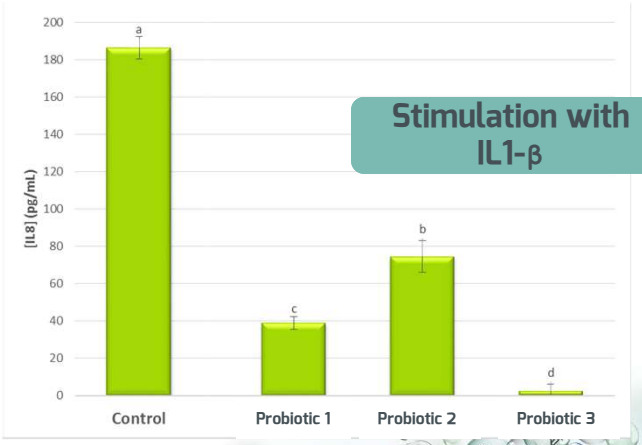
Probiotic effect on the host can be direct or indirect (through microbiota)

Probiotics act on the host : effect on the intestinal barrier, on inflammation





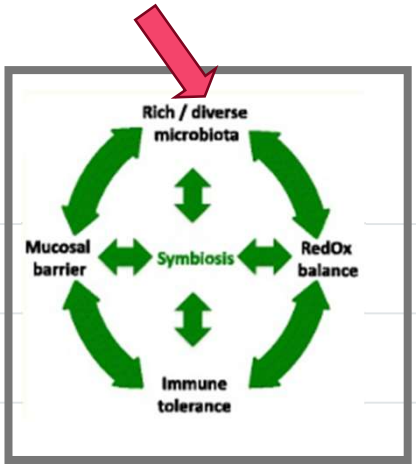




Stimulation with IL1-β

- Model: Caco-2 cells established in monolayer in a transwell system
- TEER measurement over time
- Anti-inflammatory properties: IL8 production
- Similar can be done for antioxydant properties

Probiotic can orientate towards a more favorable microbiota



Degrades oligosaccharides and produces SCFAs, especially butyrate

Breakdown polysaccharides to oligosaccharides

The main types of probiotics in animal production

Type *Lactobacillus*	Type *Bifidobacterium*	Other lactic acid bacteria	Other microorganisms
L. brevis[a]	*B. animalis*[a]	*Enterococcus faecalis*	*Bacillus cereus*
L. casei[a]	*B. longum*[a]	*Enterococcus faecium*	*Bacillus licheniformis*[a]
L. crispatus[a]	*B. pseudolongum*	*Lactococcus lactis*[a]	*Bacillus subtilis*[a]
L. farciminis[a]	*B. thermophilum*	*Leuconostoc citreum*[a]	*Propionibact. Freudenreichi*[a]
L. fermentum[a]		*Leuconostoc lactis*[a]	*Saccharomyces cerevisiae (boulardi)*[a]
L. murinus		*Leuconostoc mesenteroides*[a]	*Saccharomyces pastorianus*[a]
L. gallinarium[a]		*Pediococcus acidilactici*[a]	*Kluyveromyces fragilis*
L. paracasei[a]		*Pediococcus pentosaceus*[a]	*Kluyveromyces marxianus*[a]
L. pentosus[a]		*Streptococcus infantarius*	*Aspergillus orizae*
L. plantarum[a]		*Streptococcus salivarius*	*Aspergillus niger*
L. reuteri[a]		*Streptococcus thermophilus*[a]	
L. rhamnosus[a]		*Sporolactobacillus inulinus*	
L. salivarius[a]			

Markowiak and Śliżewska *Gut Pathog (2018) 10:21*

Research & Innovation

The future of probiotics in animal nutrition

- **New type of probiotics**

- Ex of 2nd generation probiotics

Butyricicoccus pullicaecorum Reduces Feed Conversion and Protects from Potentially Harmful Intestinal Microorganisms and Necrotic Enteritis in Broilers

Front. Microbiol., 21 September 2016 | https://doi.org/10.3389/fmicb.2016.01416

- **Precise Nutrition through Machine learning and artificial intelligence**

- Improve characterization of the biological response to probiotics

- Develop predictive modelling of microbial and host responses to probiotics

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Take home messages

- Animal nutrition today = feeding ‘athletes’ keeping them resilient
- Microbiota (its functions and its ecology) is key for improving gut health (inflammation, leaky gut, infections)
- Animal nutritionists have to take into account the microbiota, and not only the animal *per se*
- Probiotics in animal nutrition are part of the solutions to succeed demedication
- Future should focus on new type of probiotics and precise nutrition

Thank you !