Maternal Microbiota Regulates Intestinal Development and Immune Function in Offspring

ANIMAL NUTRITION GENOME AND GERMPLASM INNOVATION RESEARCH CENTER
HUNAN AGRICULTURAL UNIVERSITY

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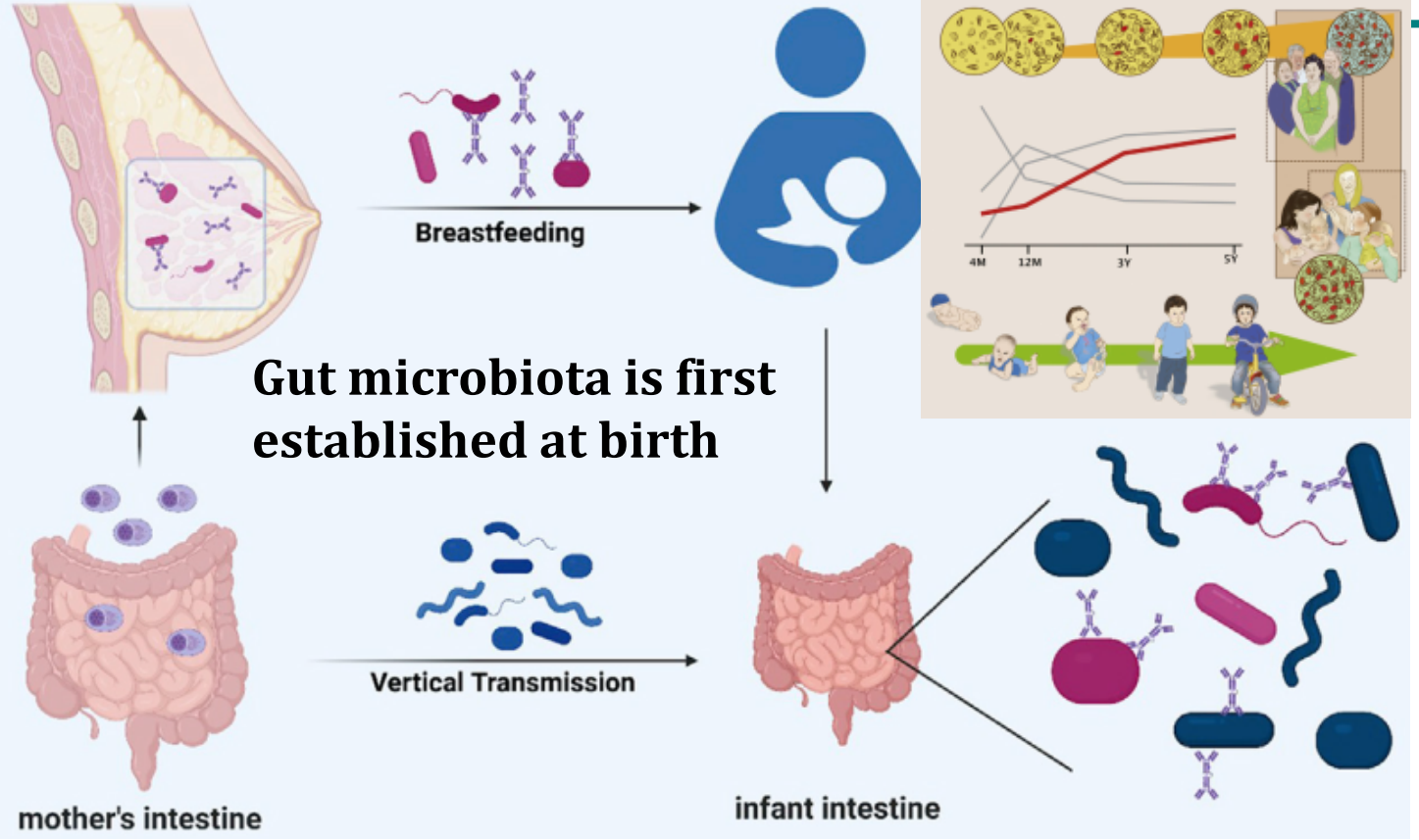
朴诚奋勉 求实创新

Microbiota vertical transmission → postnatal gut health



Maternal gut microbiota

↓

Offspring early microbial colonization ↑

↓

Intestinal maturation ↑

↓

Offspring health ↑

- **Which is the dominant microbiota?**
- **Whether intervening microbiota vertical transmission could be used as a strategy to improve the growth of offspring?**

Xue et al. Microbiome (2022) 10:122; Ouyang et al. Gut Microbes (2023)15:1

Microbiota vertical transmission → postnatal gut health

Ningxiang Pig

- Indigenous Chinese porcine breed
- High stress resistance
- High fiber diet

shapes

Yorkshire Pig

Gut microbial composition and diversity

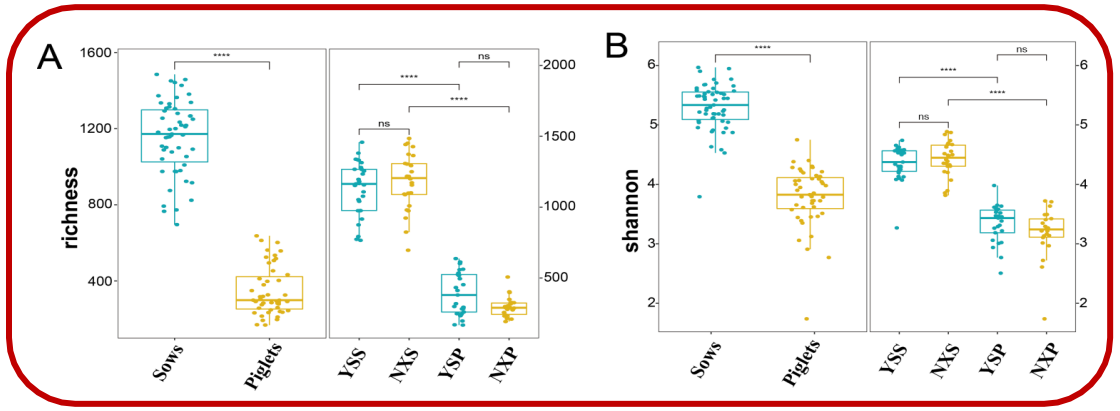
Maternal microbiota vertical transmission

Postnatal gut health of neonates

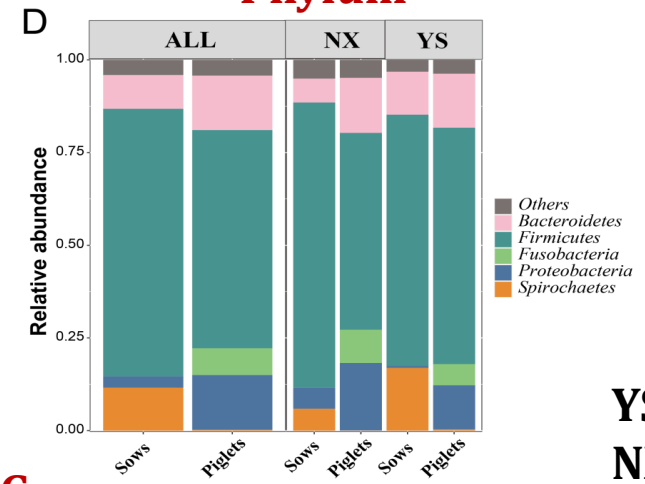
Microbiota vertical transmission → postnatal gut health

- **The distinct gut microbial diversity and composition are observed between the two breeds.**

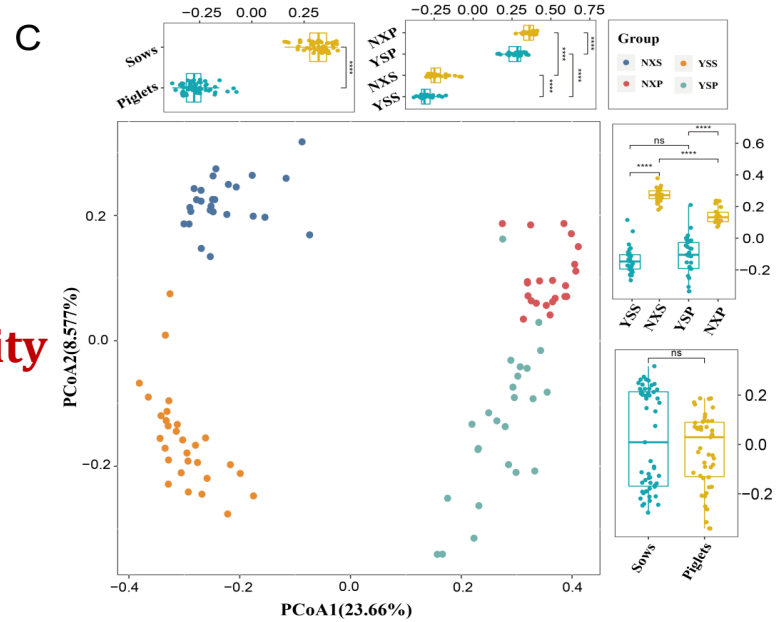
Alpha diversity



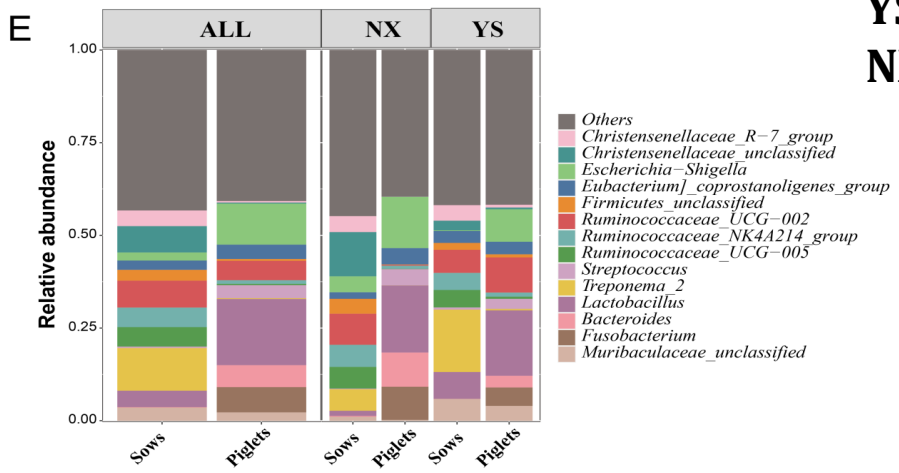
Phylum



Beta diversity



Genus



YSS: Yorkshire sows
NXS: Ningxiang sows
YSP: Yorkshire piglets
NXP: Ningxiang piglets

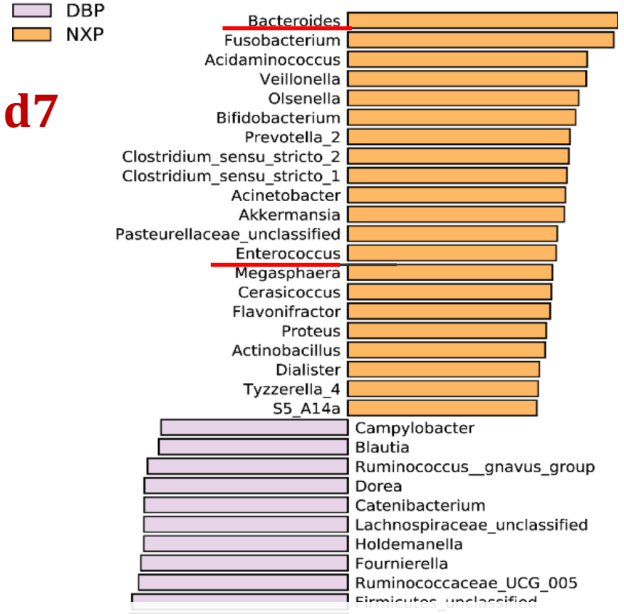
Microbiota vertical transmission → postnatal gut health

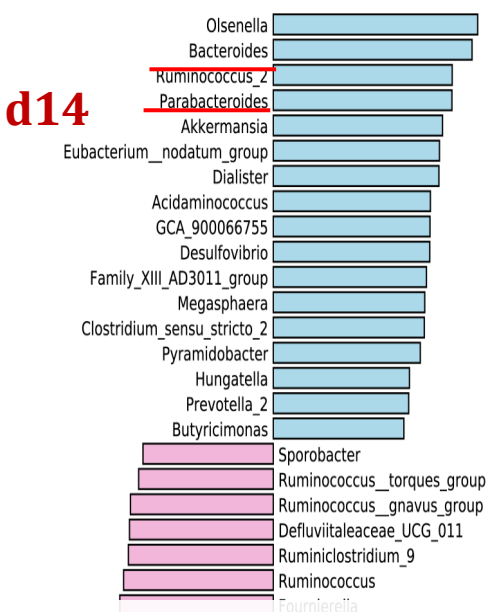
- **Three microbes are positively correlated with fecal sIgA, acetate and propionate concentrations**

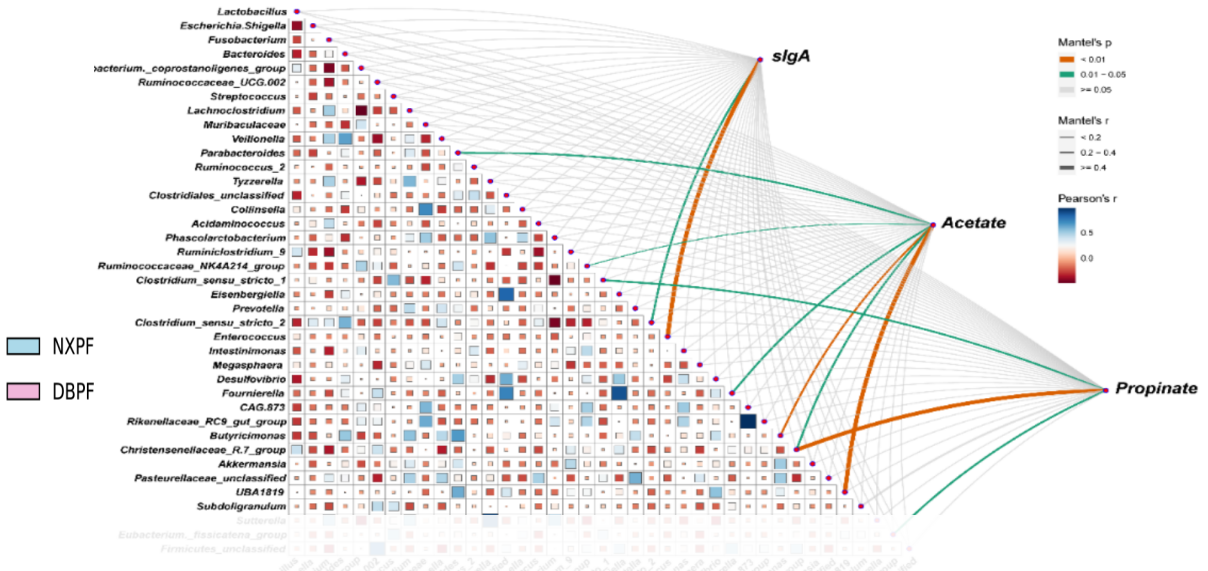
7-d-age: *Enterococcus hirae*

14-d-age and 21-d-age : *Parabacteroides distasonis*

7-d-age, 14-d-age and 21-d-age : *Bacteroides thetaiotaomicron*



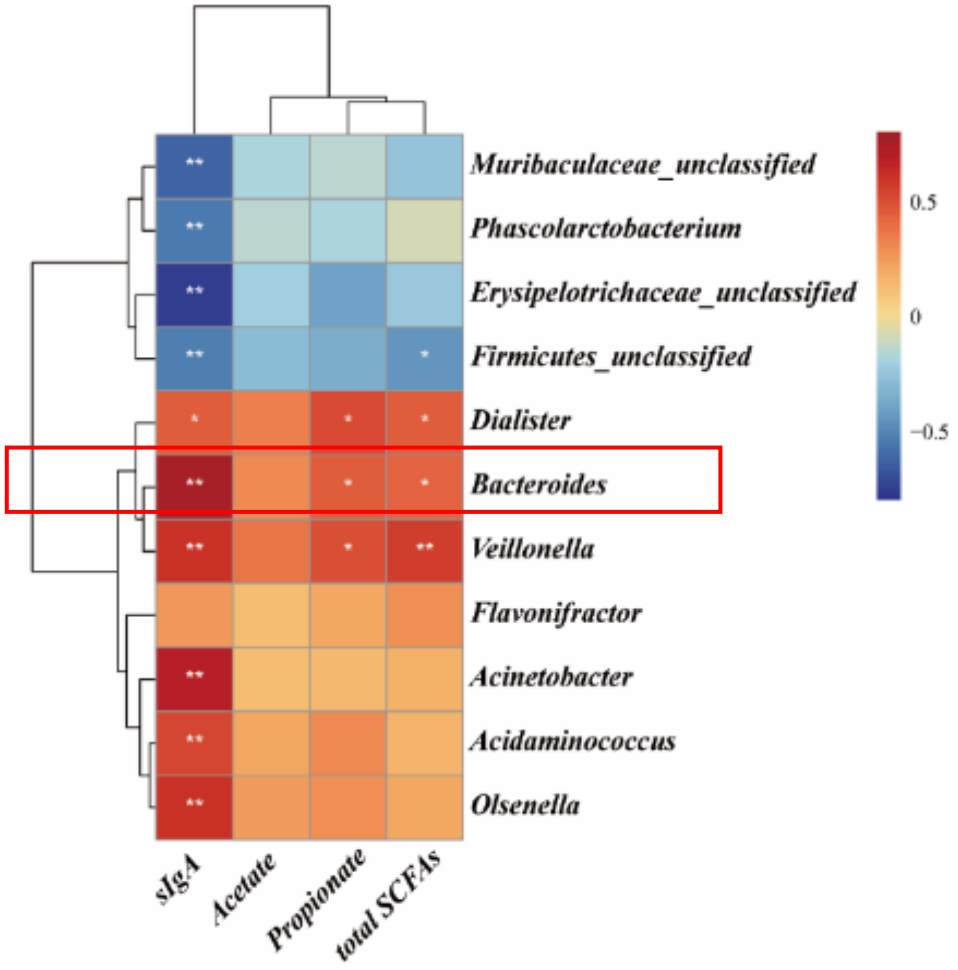


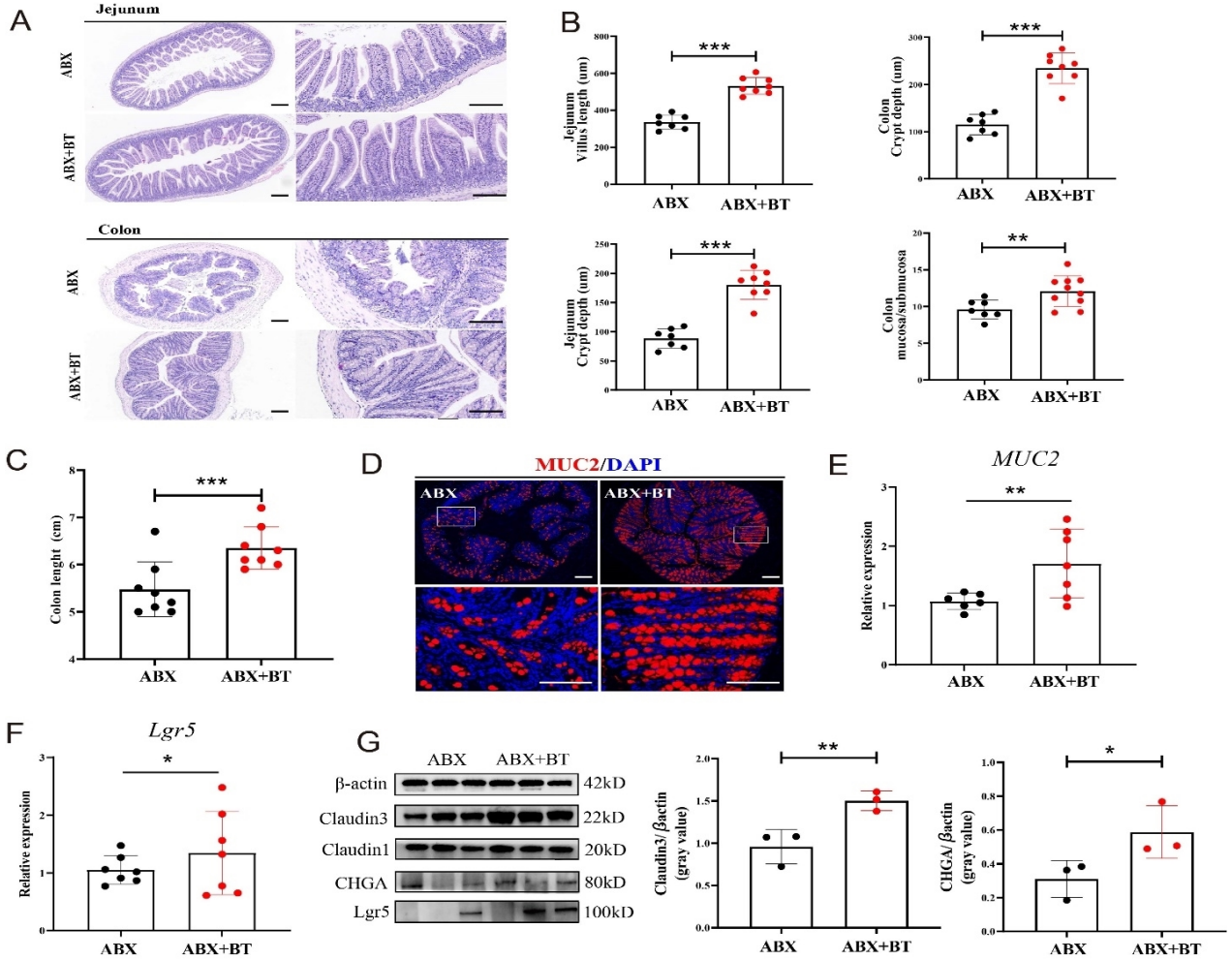


***Enterococcus hirae*, *Enterococcus hirae*, and *Enterococcus hirae* might have benefits on the intestinal barrier and immune function**

Bacteroides thetaiotaomicron → postnatal gut health

- ***B. thetaiotaomicron*** **regulates sIgA secretion of intestine in piglets.**
- ***B. thetaiotaomicron*** **promotes intestinal development by increasing the colon length and *lgr5* gene expression, and has benefits on barrier function.**

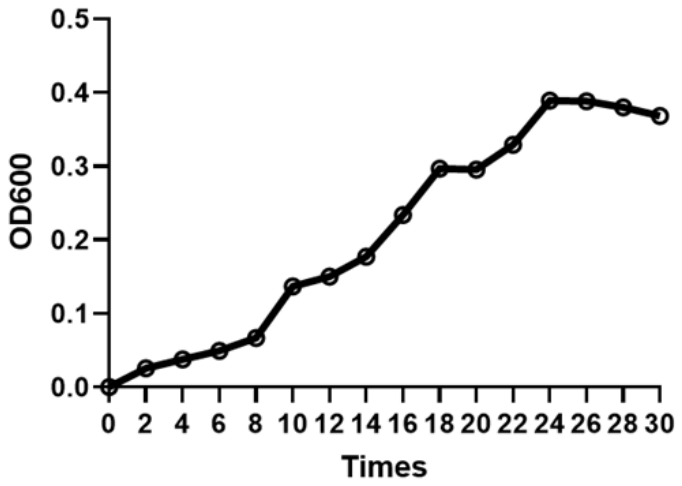




Parabacteroides distasonis → postnatal gut health

- ***P. distasonis (Pbd)*** **inhibits the growth of pathogenic bacteria**

P.distasonis **growth curve**



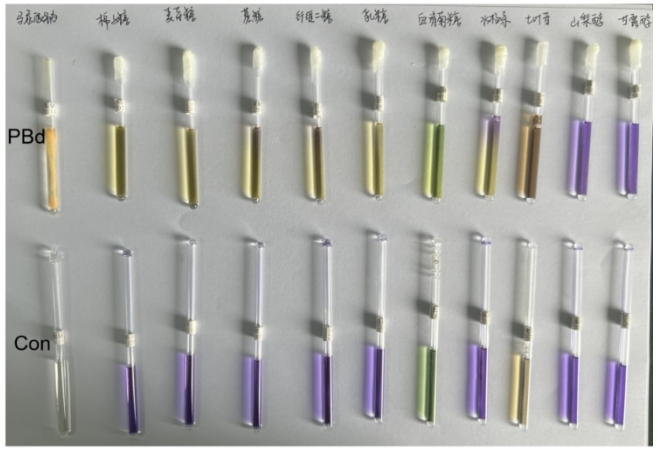
Inhibitory effect of *Parabacteroides distasonis* dieldrin from pigs on *Escherichia coli k88*, *Salmonella* and *Staphylococcus*

Indicator bacteria	Diameter of bacteriostatic zone d mm (n=5)					Mean value dmm
Escherichia coli k88	18.40	20.98	19.39	14.62	17.52	18.18
Salmonella	17.66	16.38	17.97	19.97	12.51	16.90
Staphylococcus	13.68	14.11	15.56	17.34	16.67	15.47

P.distasonis **activity**

P.distasonis

Con

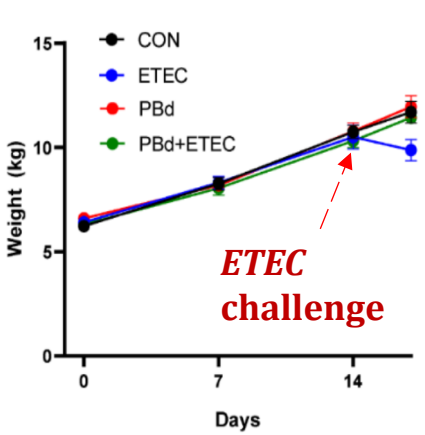


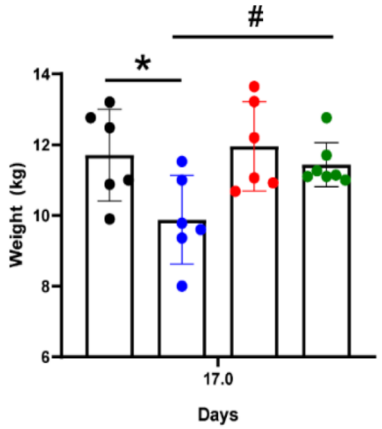
Escherichia coli k88 ***Salmonella*** ***Staphylococcus aureus***

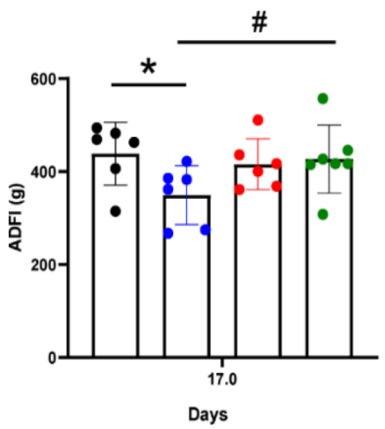
Parabacteroides distasonis → postnatal gut health

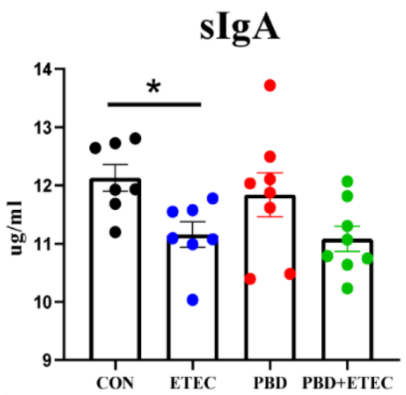
- ***P. distasonis (Pbd)*** **improves the growth inhibition by increasing body weight, and decreases intestinal permeability and repairs morphologic injury induced by ETEC in piglets (*Duroc* × *Landrace* × *Yorkshire*).**

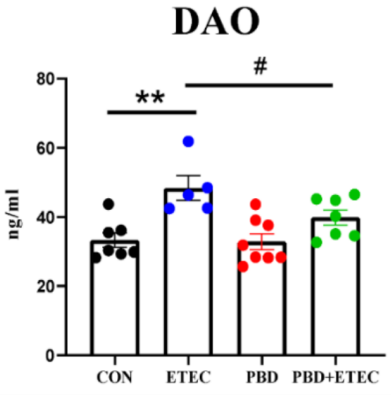
Gut permeability

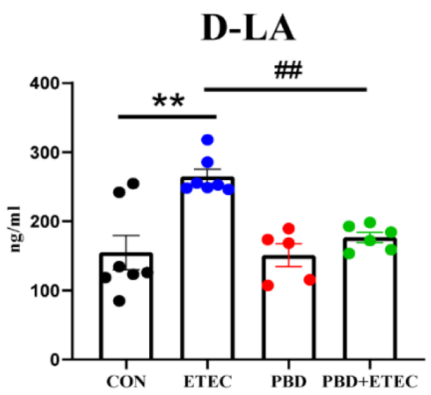


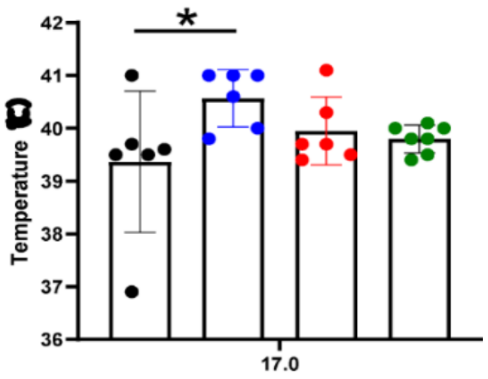




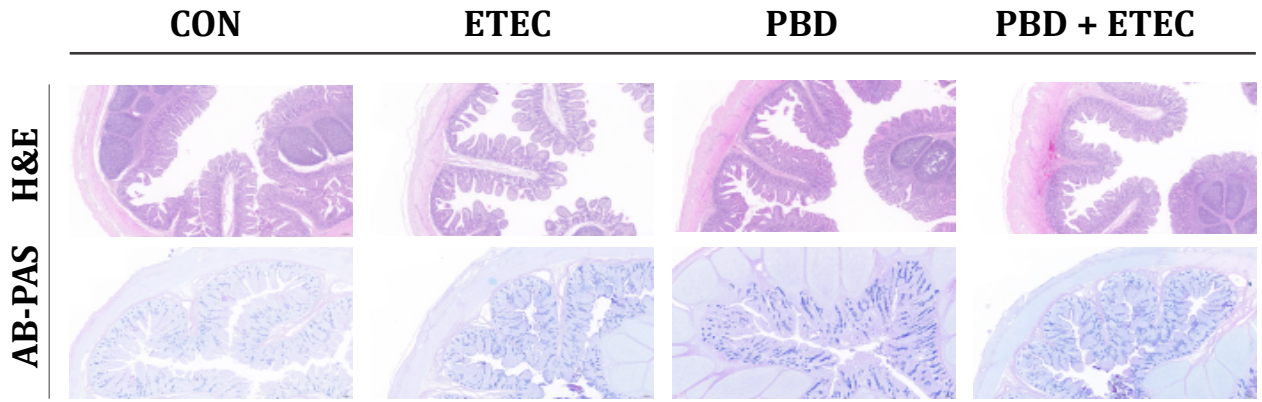


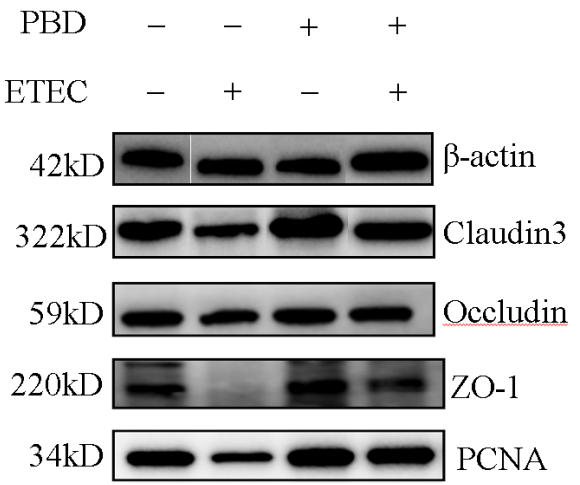






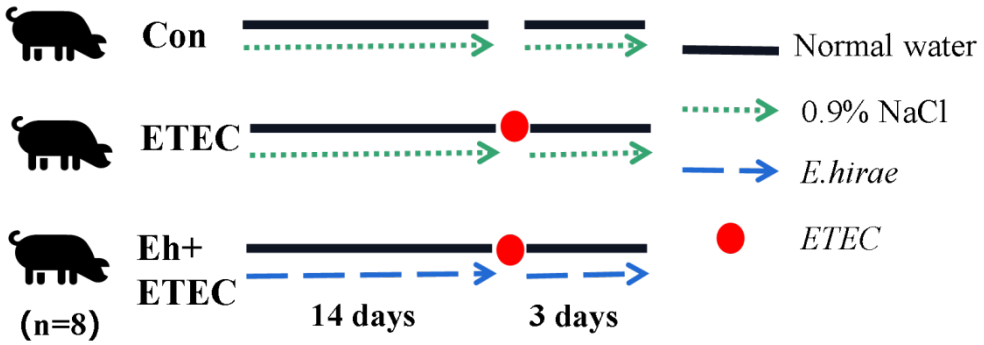
Morphologic injury induced by ETEC



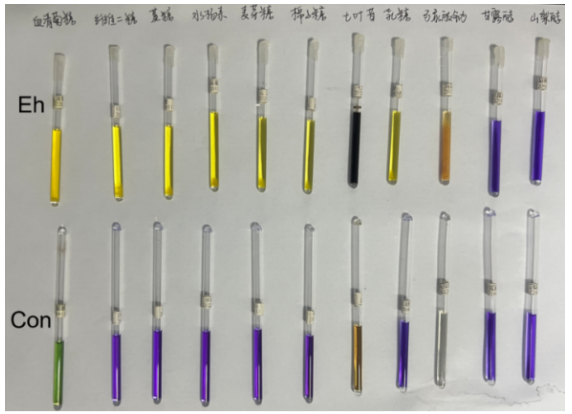


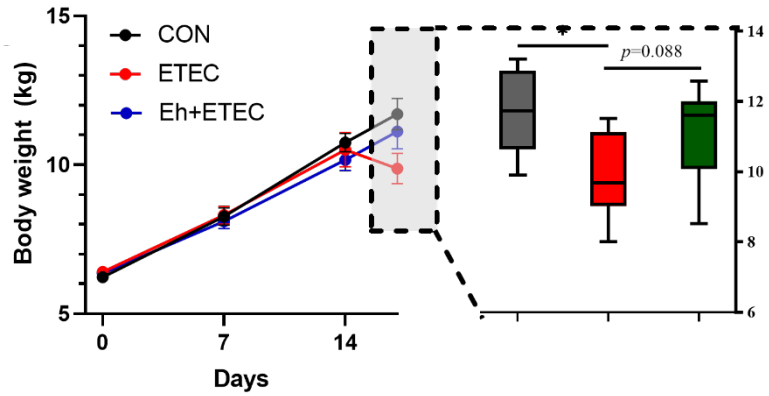
Enterococcus hirae → postnatal gut health

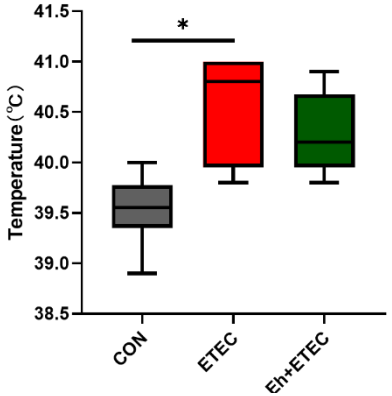
- ***E. hirae (Eh)*** **increases the body weight and alleviates the intestinal inflammation induced by ETEC in piglets (*Duroc* × *Landrace* × *Yorkshire*).**

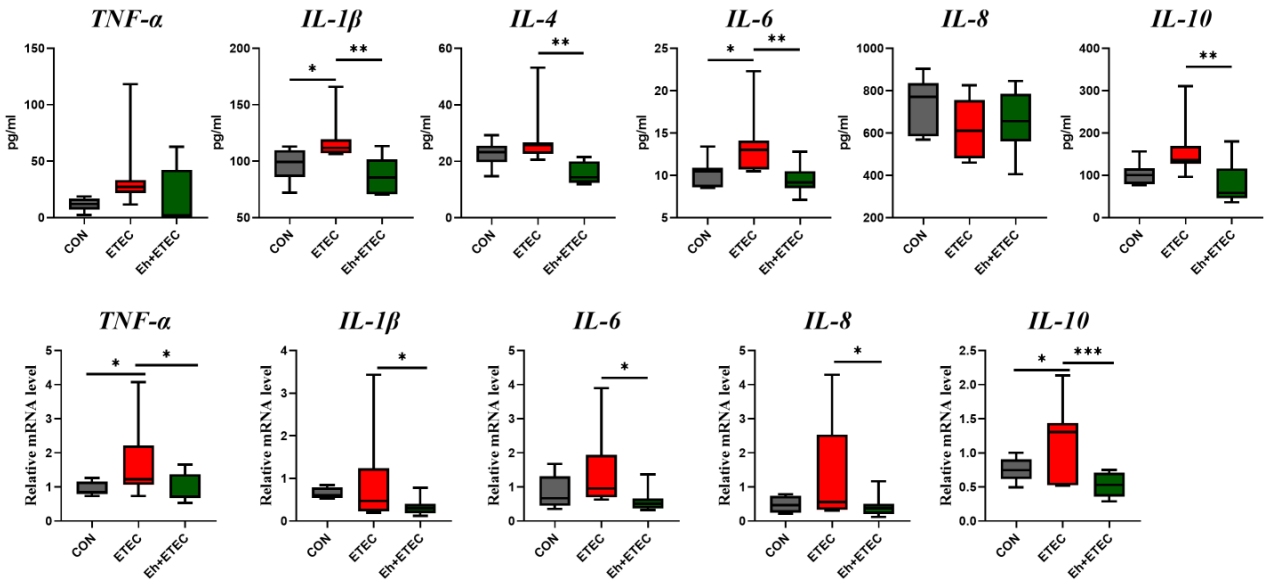


***E. hirae* activity**



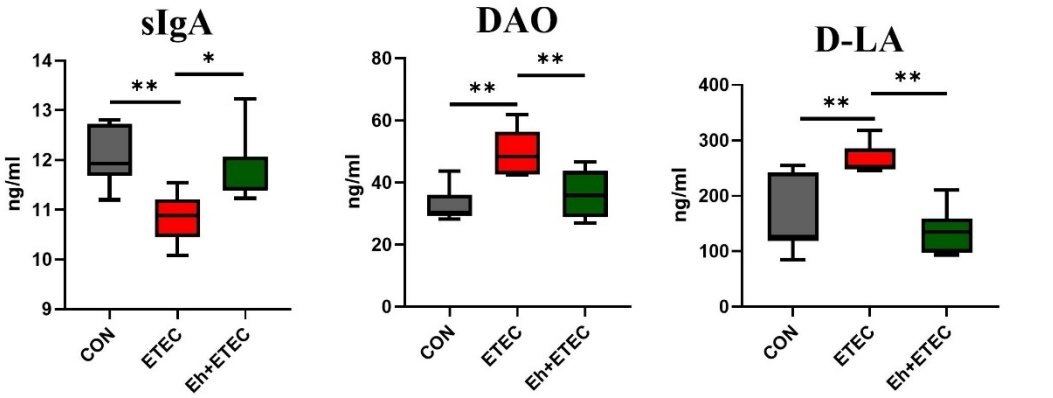


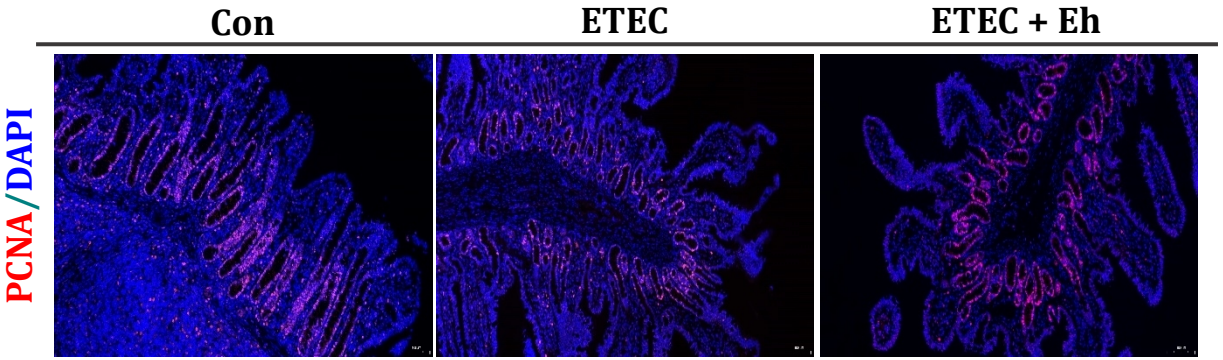


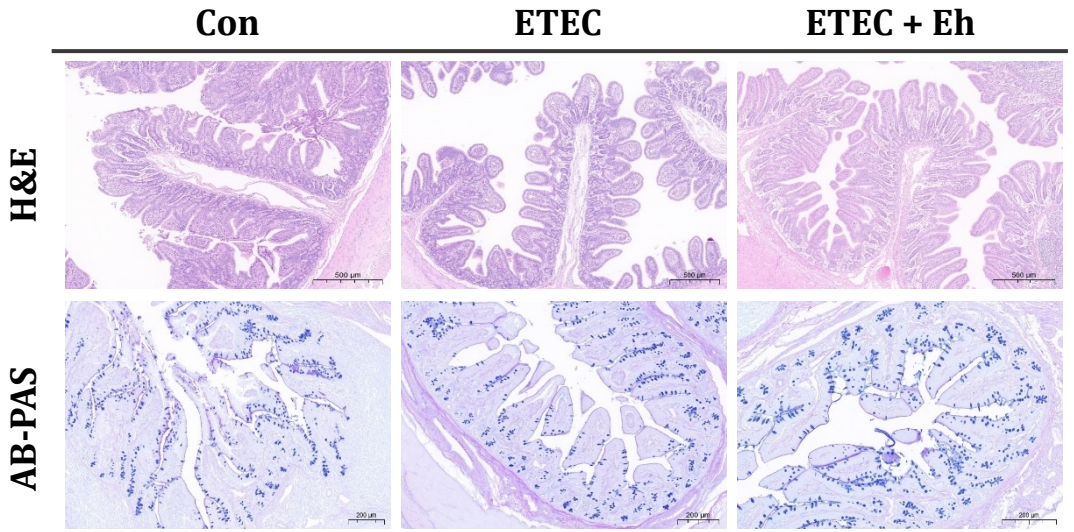


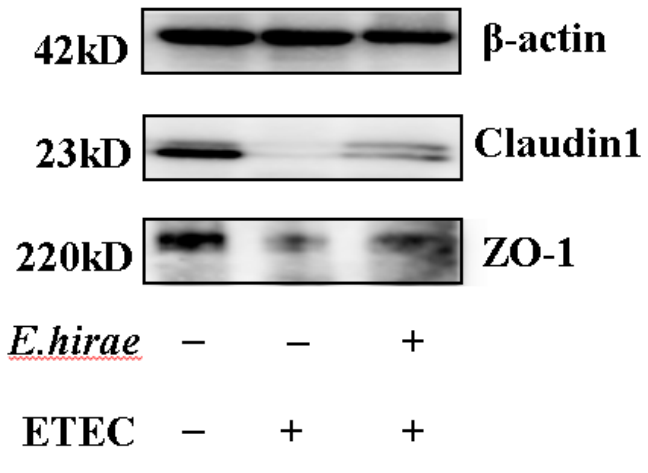
Enterococcus hirae → postnatal gut health

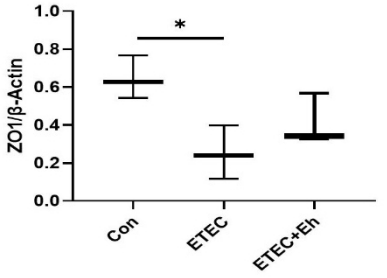
- ***E. hirae (Eh)*** **promotes intestinal sIgA secretion and proliferation and thereby repairs the intestinal injury induced by ETEC in piglets (*Duroc* × *Landrace* × *Yorkshire*).**

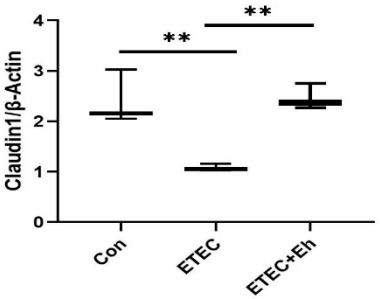










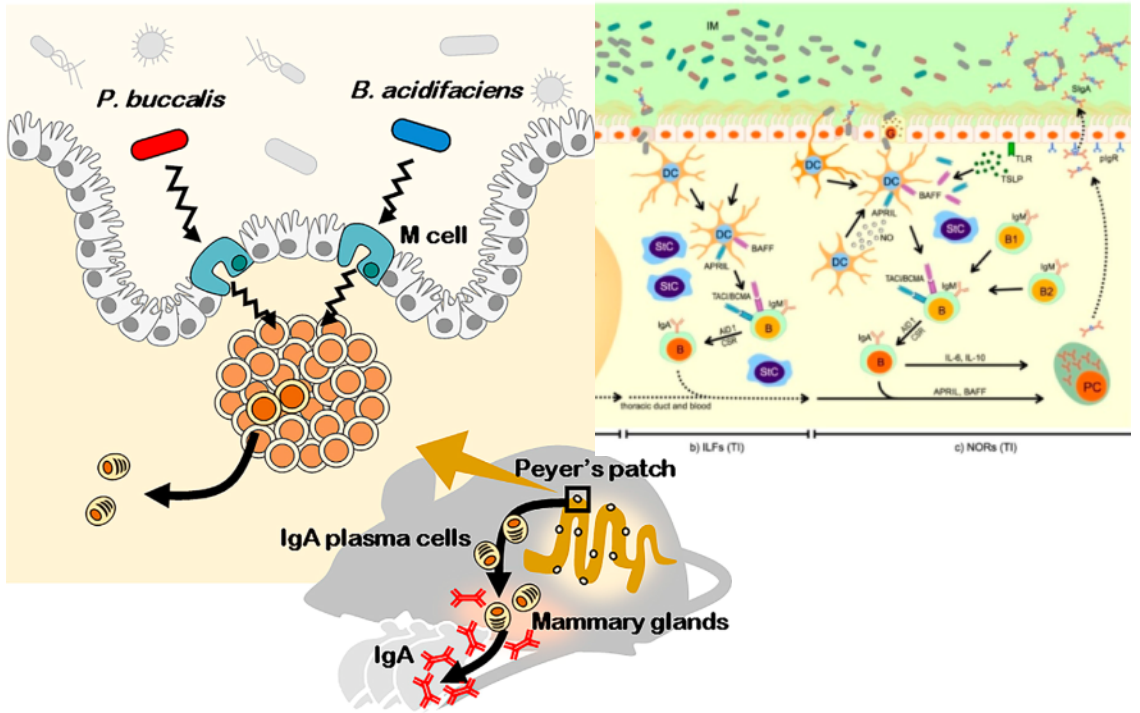


Gut microbiota-mammary gland axis → postnatal health

Maternal gut microbiota

Vertical transmission

Microbiota-Peyer's patches-Mammary gland



Milk immunoglobulins ↑ → **Microbial colonization ↑** → **Intestinal immune system development ↑**

Which microbiota of the maternal gut connectively influence the secretion of immunoglobulins into milk?

Xue et al. Microbiome (2022) 10:122; Wang et al. Gut Microbes (2022)14:1

Gut microbiota-mammary gland axis → offspring health

Ningxiang Pig

Yorkshire Pig

Onset of parturition

Sow feces

Sow colostrum

16S RNA sequencing

Gut microbe related to milk immunoglobulin production

BALB/c

GD 0 | GD 10 | Gavage, 10 or 11d | GD 21

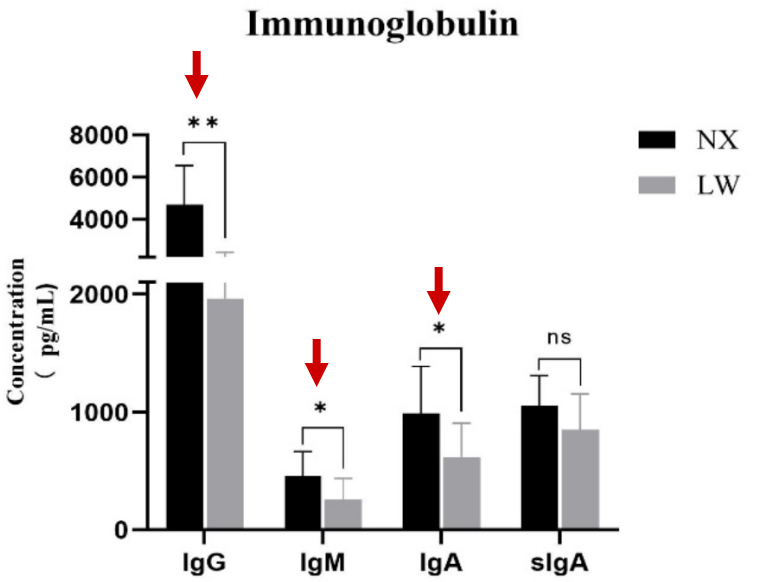
Pre-gavage:
NS 200 μL/mouse, 7d

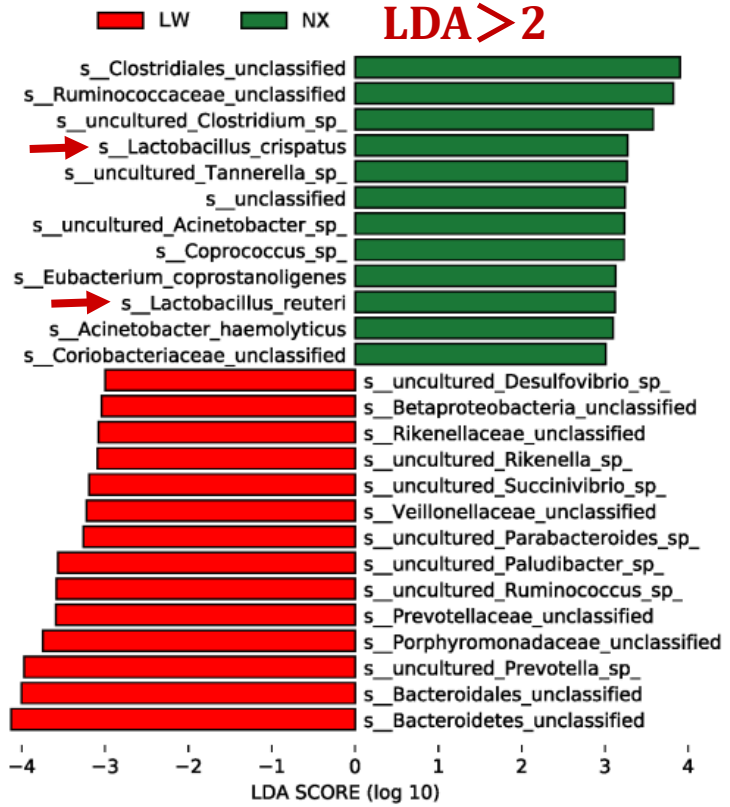
CON — NS

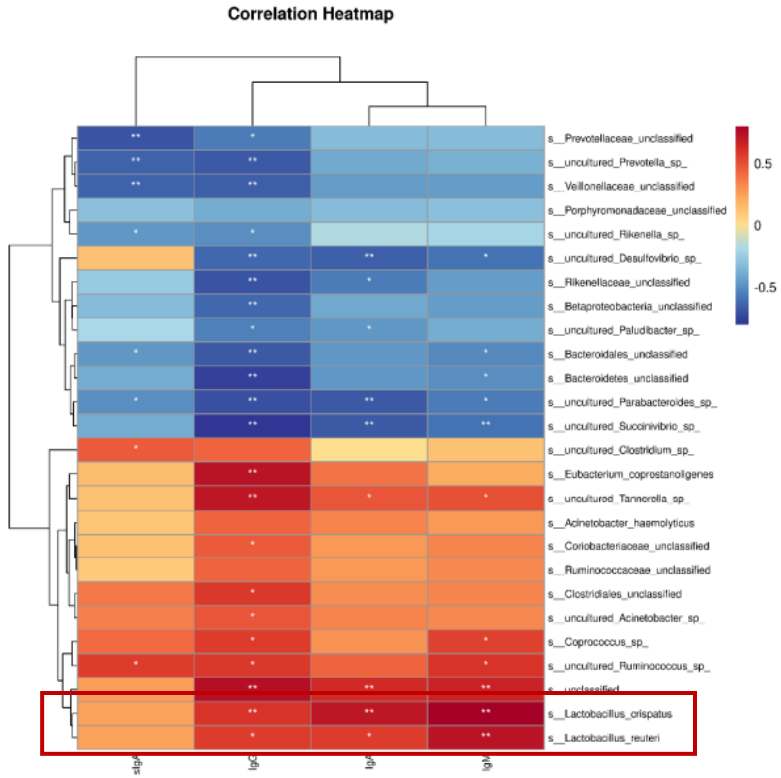
L-treatment — *Lactobacillus reuteri* SG6-2

Gut microbiota-mammary gland axis → offspring health

- The concentrations of IgG, IgM, and IgA in colostrum of Ningxiang sows are higher than those in Yorkshire sows.
- *Clostridium*, *Ruminococcus*, and *Lactobacillus* are enriched in the feces of Ningxiang sows, of which *Lactobacillus crispatus* and *Lactobacillus reuteri* are significantly correlated with IgG, IgA and IgM in the colostrum.



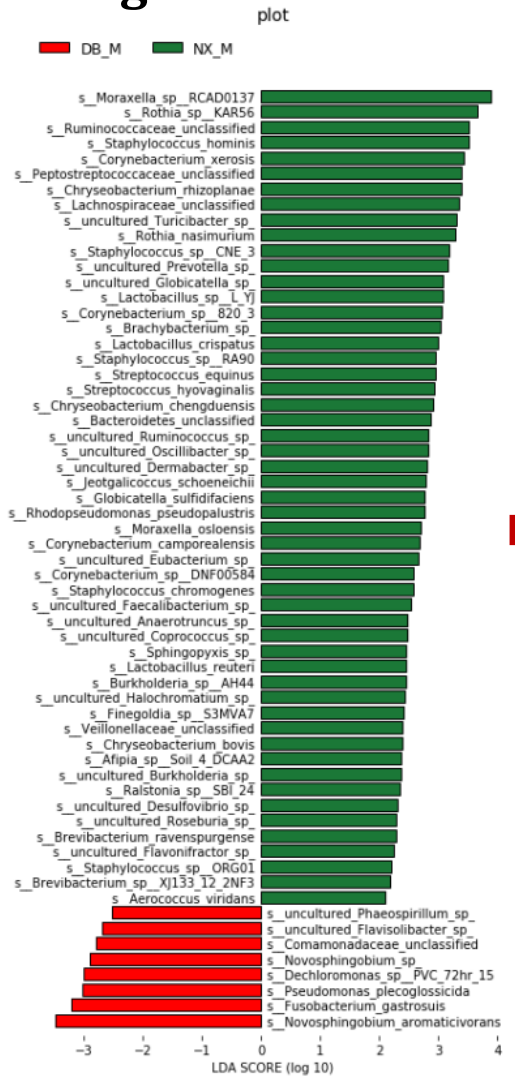




Gut microbiota-mammary gland axis → offspring health

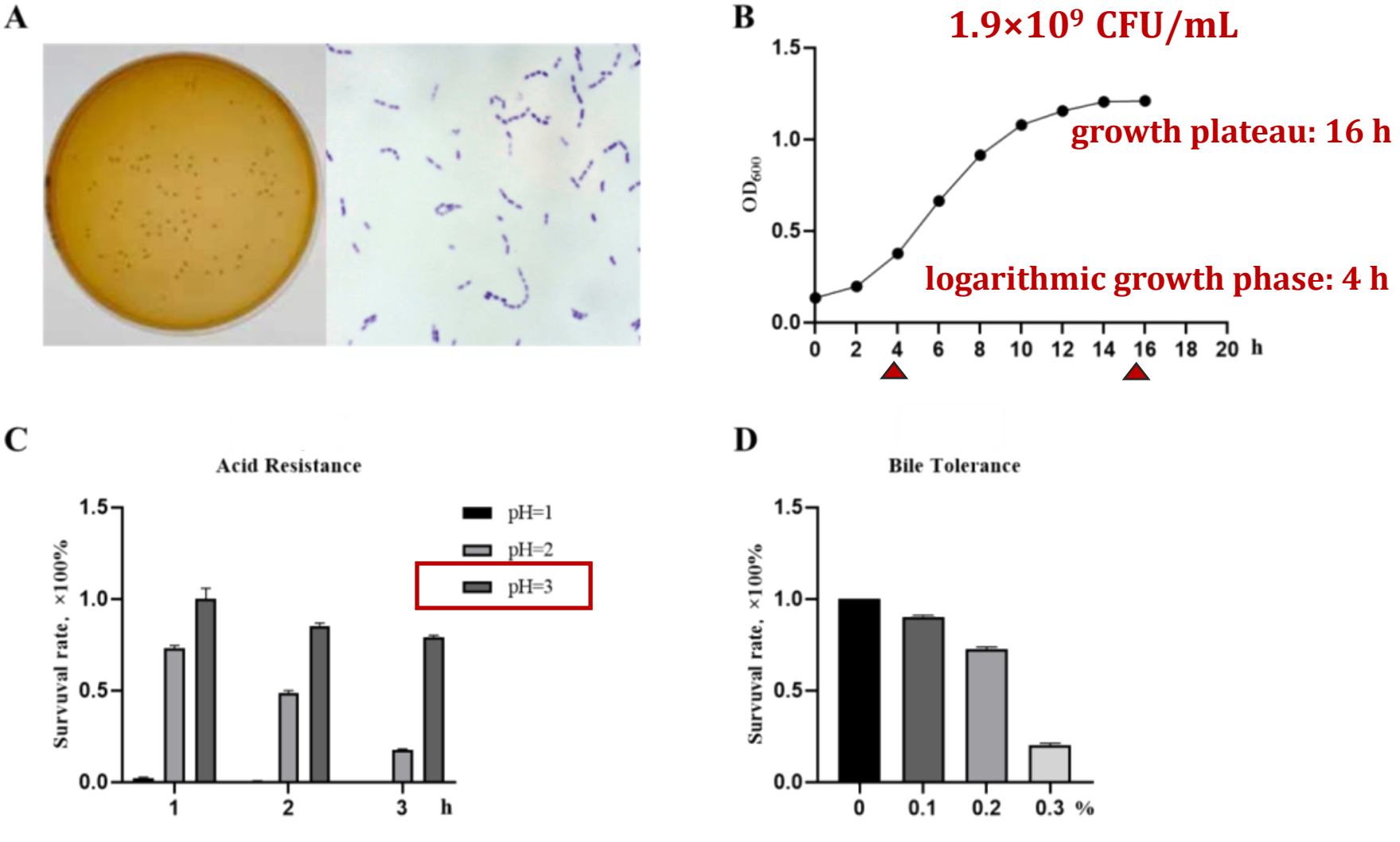
- ***Lactobacillus reuteri*** **is also the differential microbe in colostrum of Ningxiang sows, and positively correlated with IgG and IgM contents in the colostrum.**

Microbiota in colostrum
LDA＞2



Gut microbiota-mammary gland axis → offspring health

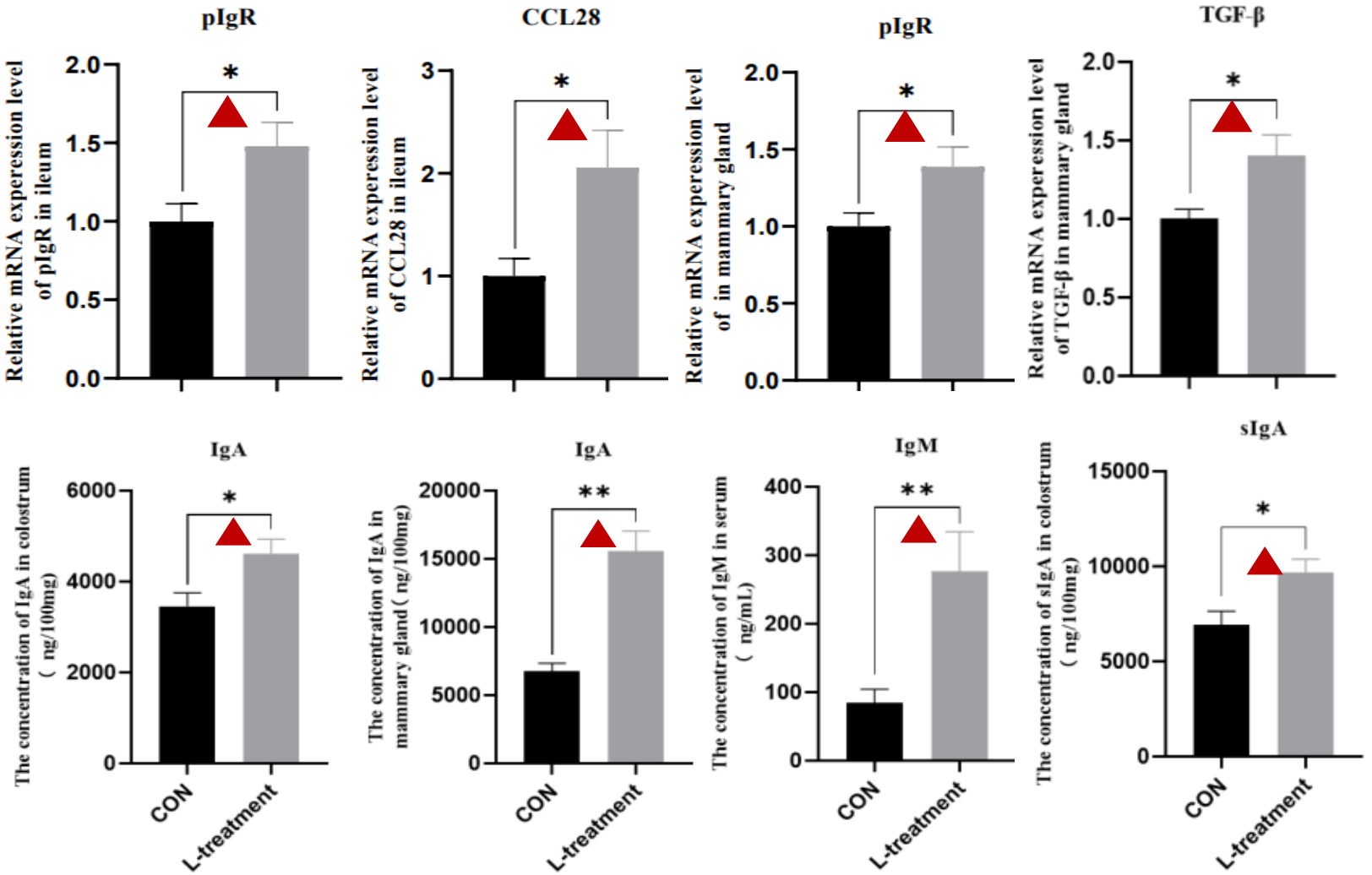
- ***Lactobacillus reuteri SG6-2*** **is separated from Ningxiang sow's feces, and characteristics as a probiotics strain .**



Gut microbiota-mammary gland axis → offspring health

- ***L. reuteri SG6-2*** **administration promotes the ileal *plgR*, *CCL28* and mammary *plgR*, *TGF-β* gene expressions, and increases immunoglobulins levels in colostrum, mammary gland, and serum.**

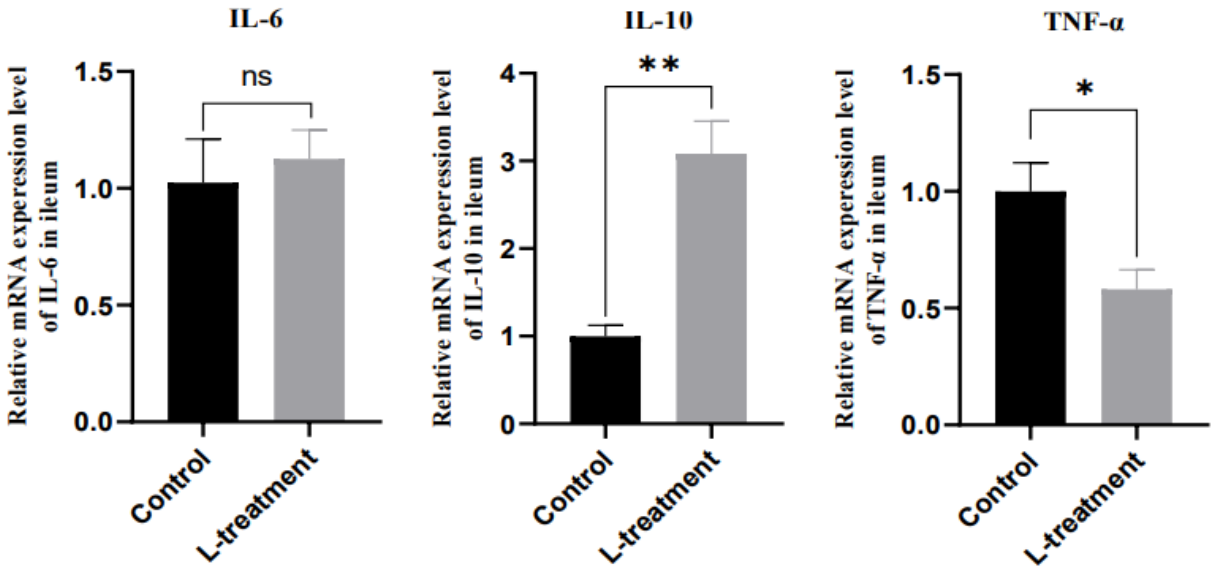
Mother

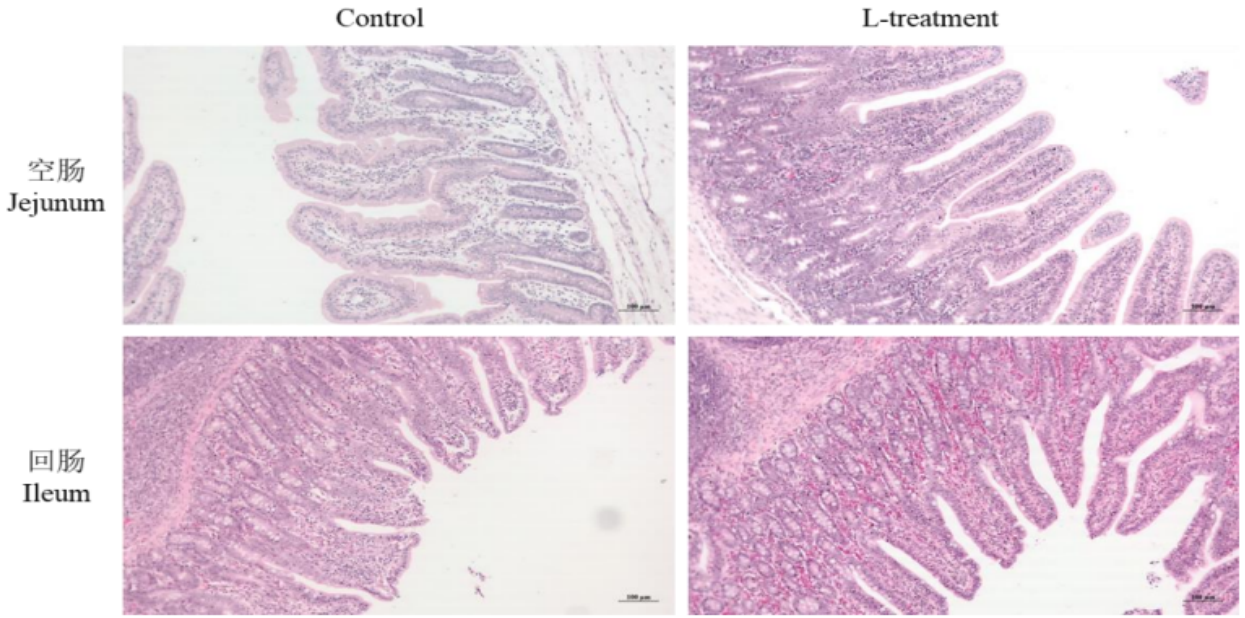


Gut microbiota-mammary gland axis → offspring health

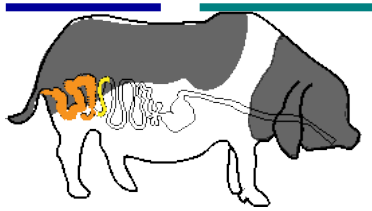
- ***L. reuteri SG6-2*** **administration improves the postnatal intestinal morphology, increases the** ***Il-10*** **but decreases** ***TNF-α*** **gene expressions in piglets.**

Offspring





In summary

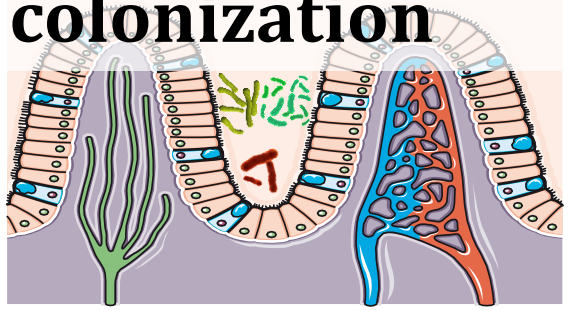


Maternal gut microbiota

E. hirae
P. distasonis
B. thetaiotaomicron

Vertical transmission

Early microbial colonization



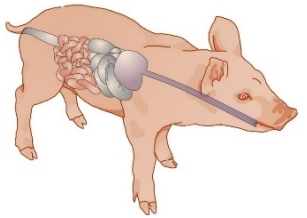
Gut microbiota-mammary gland

L. reuteri SG6-2

Plasma cells

Maternal milk IgA, sIgA, IgG, IgM↑

Intestinal maturation ↑



Offspring health↑

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THANK YOU FOR YOUR ATTENTION!

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