Effects of maternal nutrition on immune competence and microbiota composition of piglets

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Introduction

- Programming intestinal immune system via maternal intervention
  - Transmission of mucosal immune memory
  - Chickens: Rebel *et al.* (2006);Comp. Biochem. Physiol.**145**:502-508
- Microbial colonisation initiates maturation and programming of intestinal immune system
- Program intestinal immune system piglets via maternal intervention on microbial colonisation e.g. via:
  - Transmission via vaginal flora
  - Transmission via faeces
  - Transmission via colostrum and milk

Experimental set-up

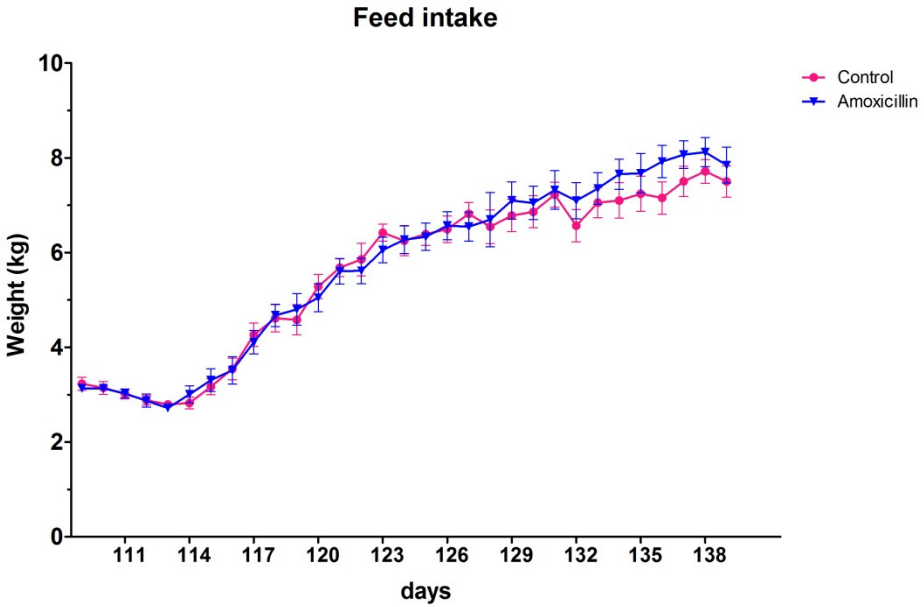
AIM:

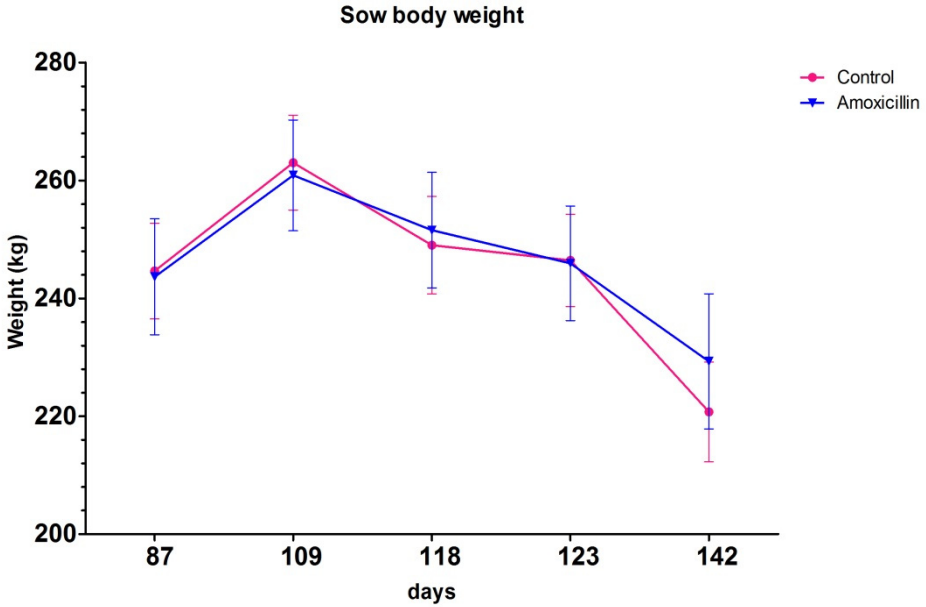
Study the effect of in feed amoxicillin treatment in sows on microbial composition and intestinal development of piglets

- Sows divided over 2 treatments:
  - Regular lactation feed (n = 16)
  - Lactation feed with amoxicillin for 1 week (n = 15)
- Effects of treatment on sows and offspring determined

Zootechnical parameters:

Sow lactation feed intake + weight





- No significant differences in feed intake nor in body weight due to amoxicillin addition
- No significant differences in reproduction due to amoxicillin treatment

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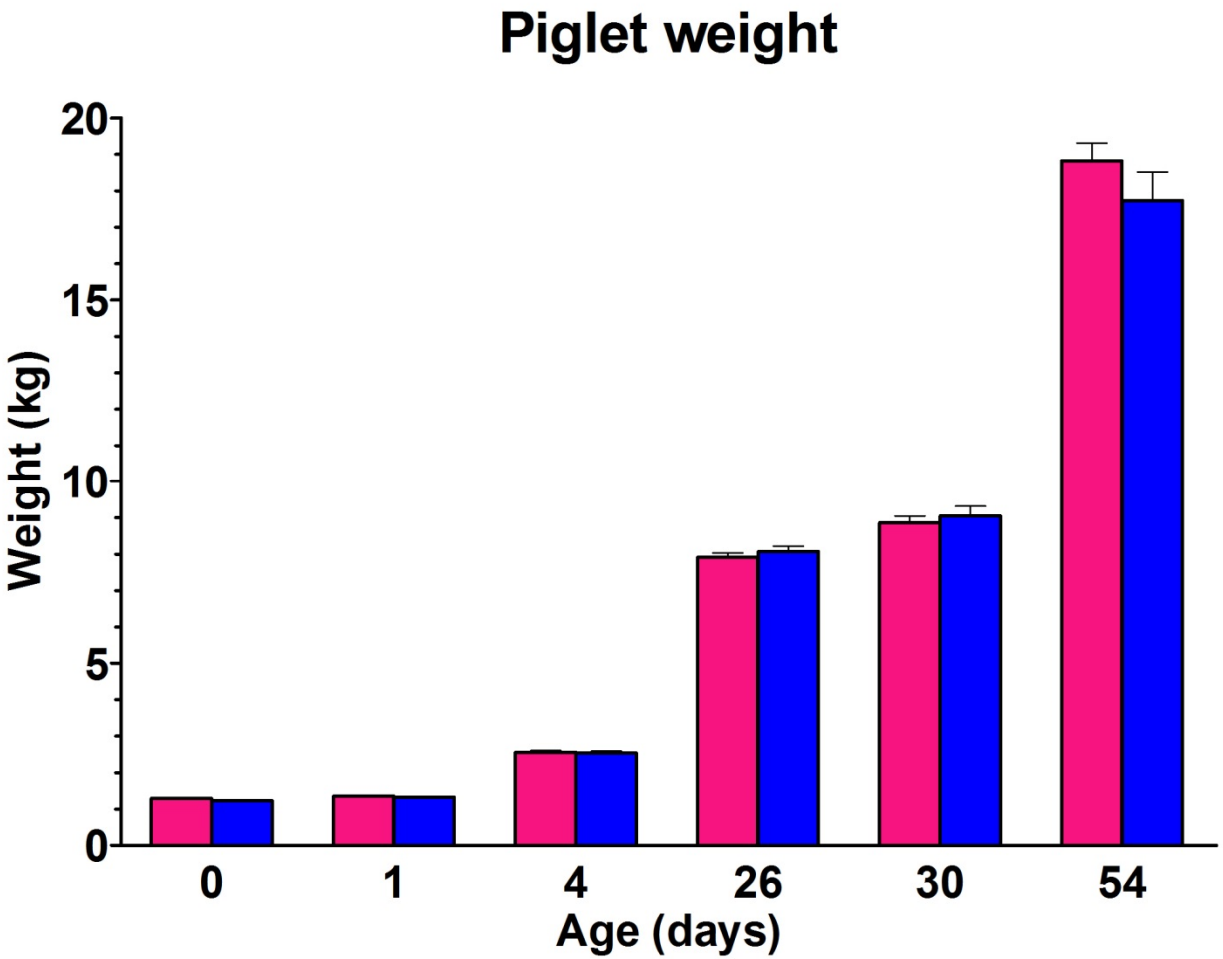
Rebel, Annemarie, 12/08/2014

Zootechnical parameters:

Piglet weight



No significant difference in growth of piglet.

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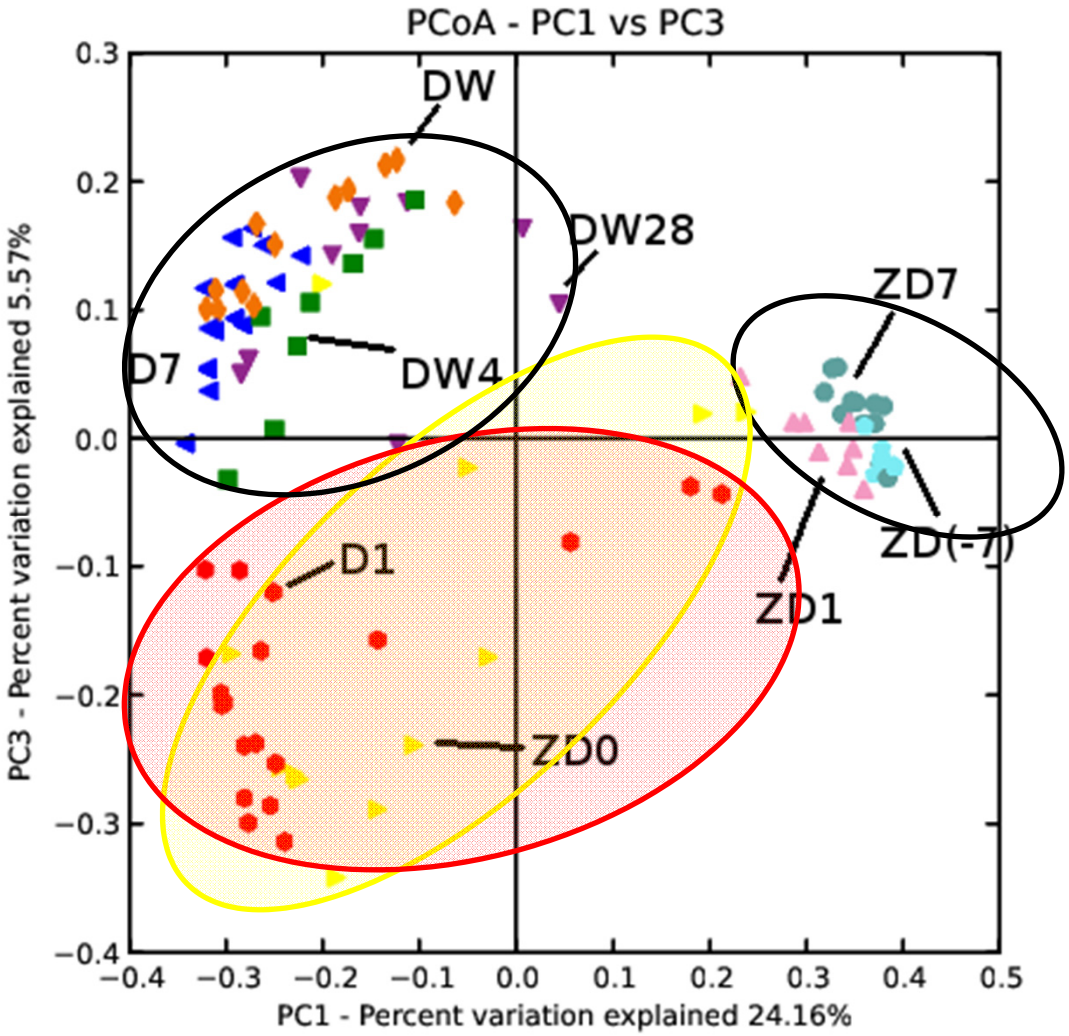
Microbiota composition

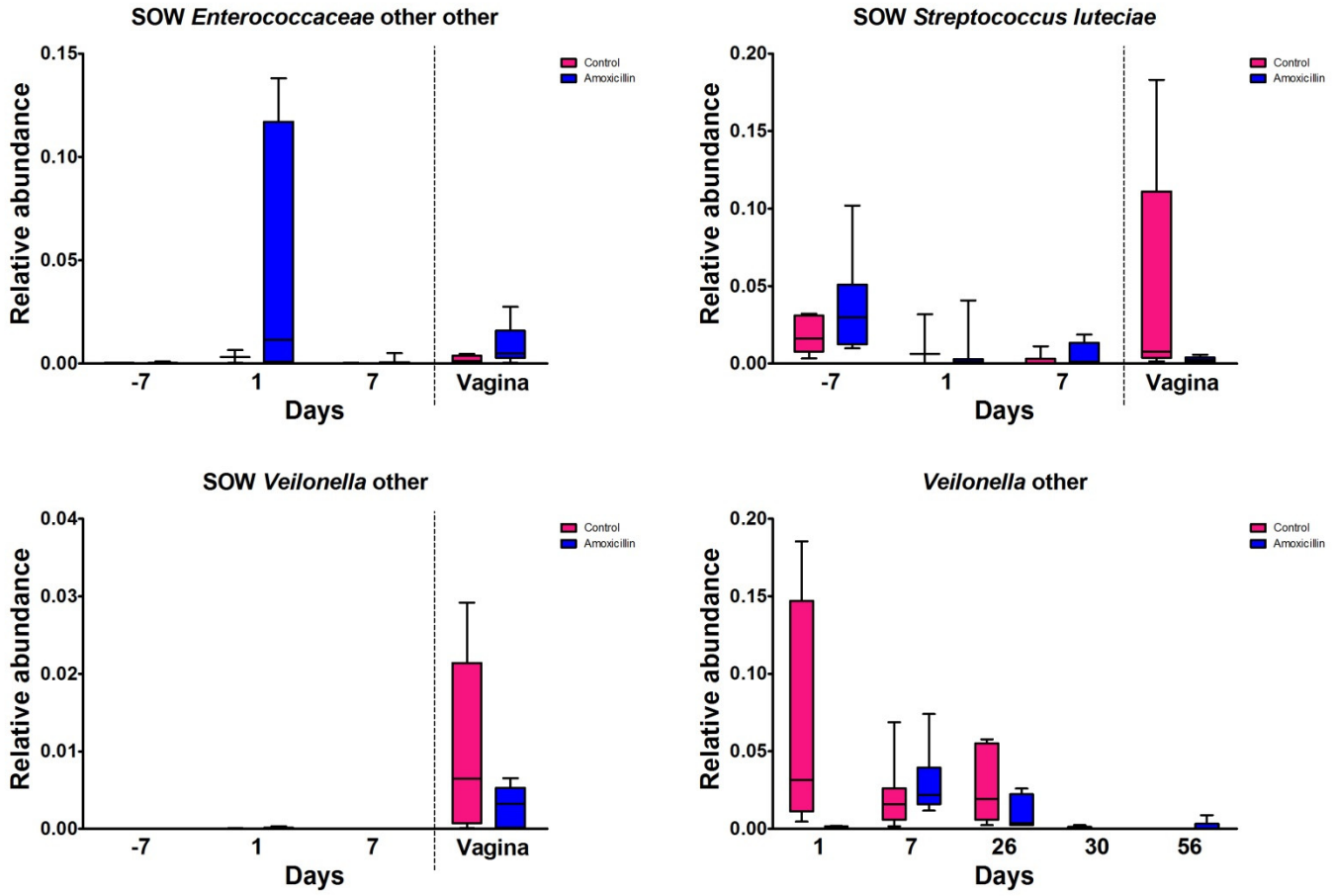
Transmission route sow - piglets

- Microbiota composition
  - Faeces sows around farrowing (ZD-7, ZD1, ZD7)
  - Vagina sows after farrowing (ZD0)
  - Ingesta proximal jejunum piglets (D1, D7, DW, DW4, DW28)
- Microbiota composition piglets day 1 overlaps microbiota sow vagina
- No significant differences between treatment groups



Microbiota composition

Effect of amoxicillin treatment



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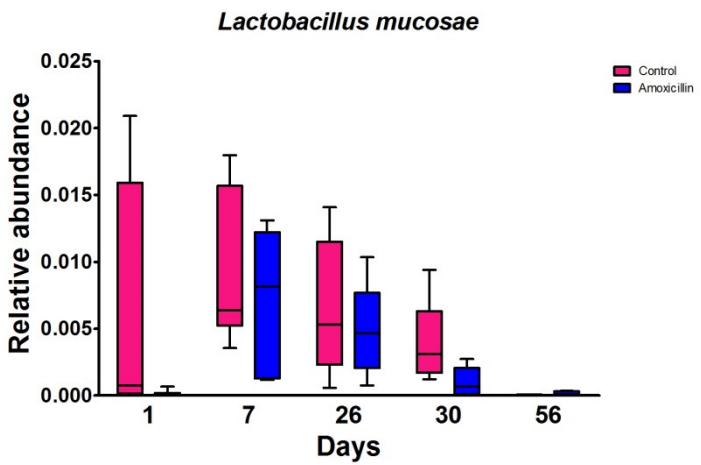
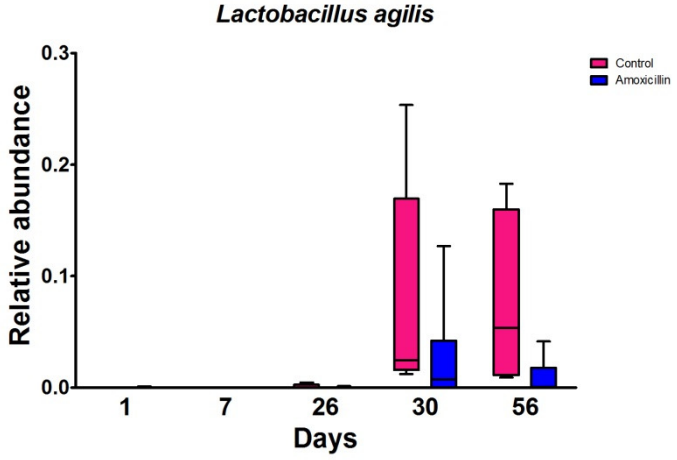
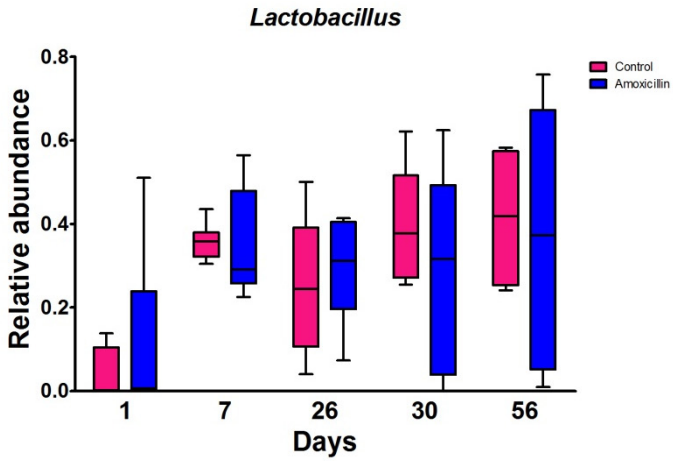
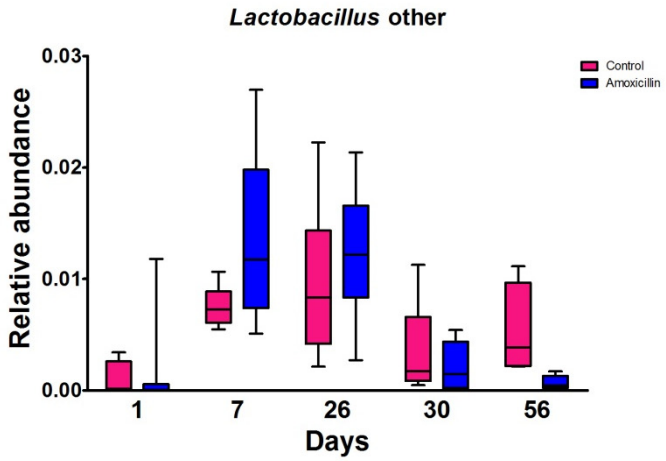
Specific changes in microbiota piglets









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Intestinal microbiota

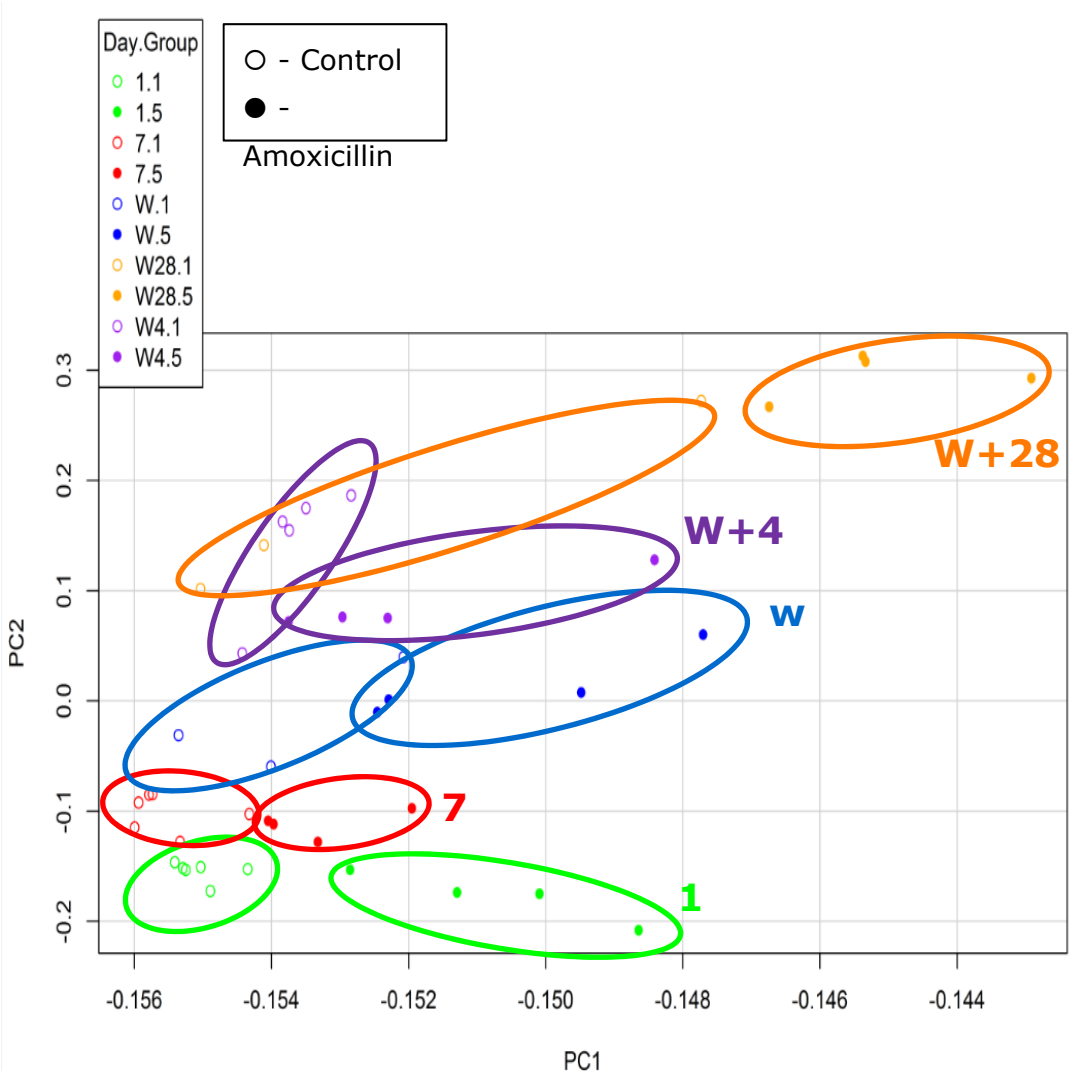
Conclusions

- Significant differences between treatment groups at level of specific microbiota in sow and piglets
- Microbiota composition piglets day 1 overlaps microbiota sow vagina

Intestinal gene expression offspring

Can maternal feed interventions affect immune competence?

- Transcriptional analysis of proximal jejunum offspring
- Principle component analysis (PCA) demonstrates differences between control and amoxicillin piglets
- PCA shows development as function of time in both groups



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Intestinal gene expression offspring

Statistics of regulated probes and genes in offspring

Table 1. Descriptive statistics of regulated probes/genes between treatments on day 1, 7, W, W+4, and W+28.

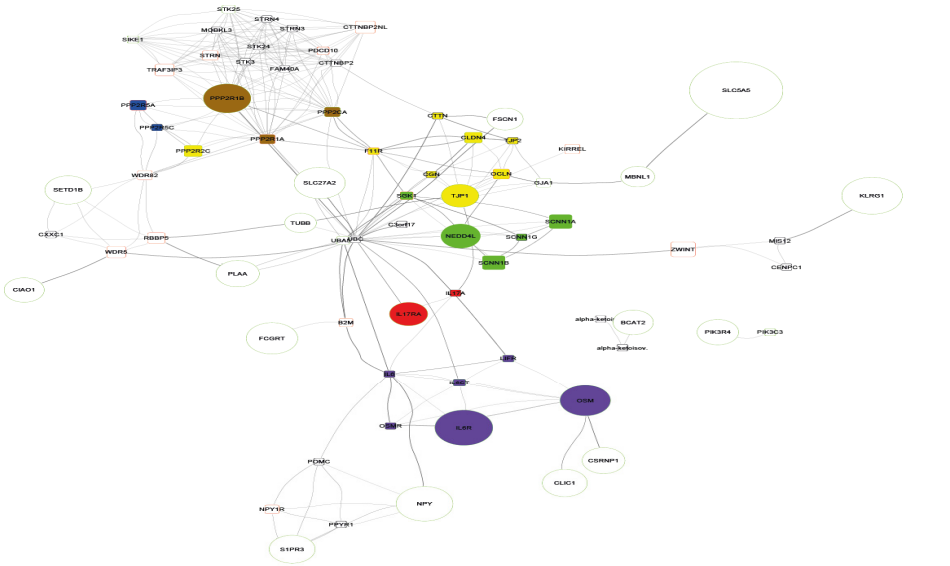
		Regulated Probes[1]		Regulated Annotated Genes[1]	
Contrast	**Day**	**Up**	**Down**	**Up**	**Down**
Amoxicillin vs control	1	159	28	52	10
Amoxicillin vs control	7	0	1	0	0
Amoxicillin vs control	28	194	301	95	148
Amoxicillin vs control	32	11	153	1	84
Amoxicillin vs control	56	154	272	67	156

[1] logFC>|1.5| and adjusted p-value < 0.05

- Most pronounced changes at weaning
- Only part of regulated probes has been annotated (30 – 50%)
- Limited regulation at day 7

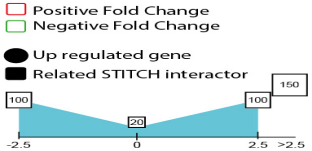
Intestinal gene expression offspring day1

- Up regulated genes



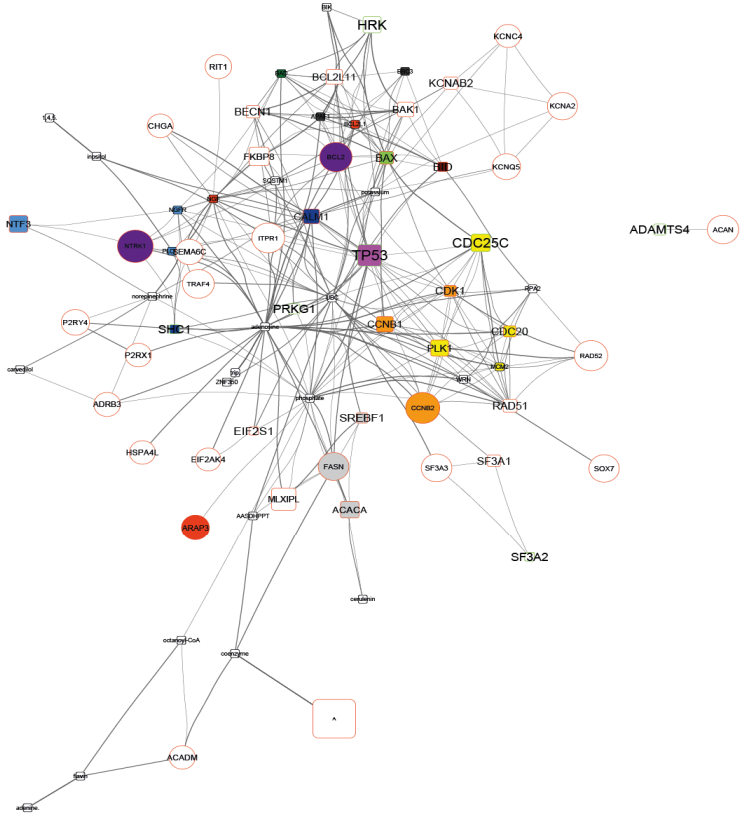
Tight Junction
TGF-beta signaling pathway, Tight Junction, Wnt signaling pathway
TGF-beta signaling pathway
Jak-STAT signaling pathway, Cytokine-cytokine receptor interaction
Cytokine-cytokine receptor interaction
Aldosterone-regulated Sodium reabsorption

Positive Fold Change
Negative Fold Change
Up regulated gene
Related STITCH interactor



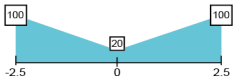
STITCH ~ medium confidence
No more than 50 interactions

- Down regulated genes



TGF-beta signaling pathway
Neurothropin signaling pathway, Insulin signaling pathway
Neurothropin signaling pathway, Apoptosis, TGF-beta signaling pathway
Neurothropin signaling pathway, Apoptosis, Insulin signaling pathway
Neurothropin signaling pathway, Apoptosis
Neurothropin signaling pathway
Insulin signaling pathway
Cell cycle, TGF-beta signaling pathway
Cell cycle, Apoptosis, TGF-beta signaling pathway
Cell cycle
Apoptosis, TGF-beta signaling pathway
Apoptosis

Positive Fold Change
Negative Fold Change
Down regulated gene
Related STITCH interactor



STITCH ~ medium confidence
No more than 50 interactions

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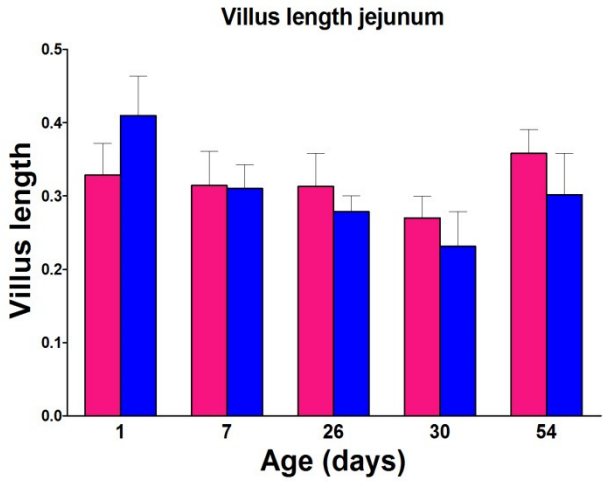
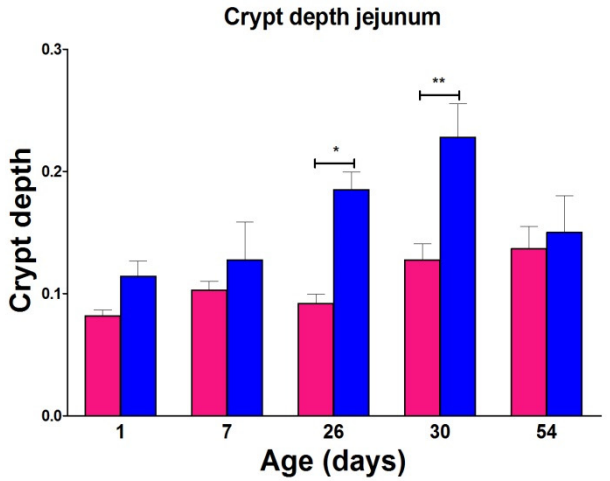
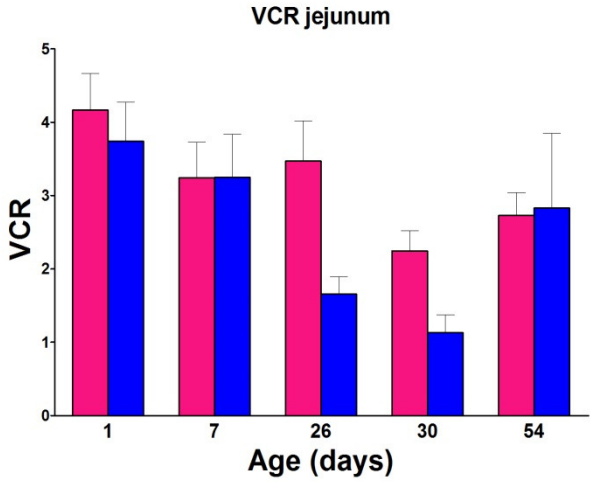
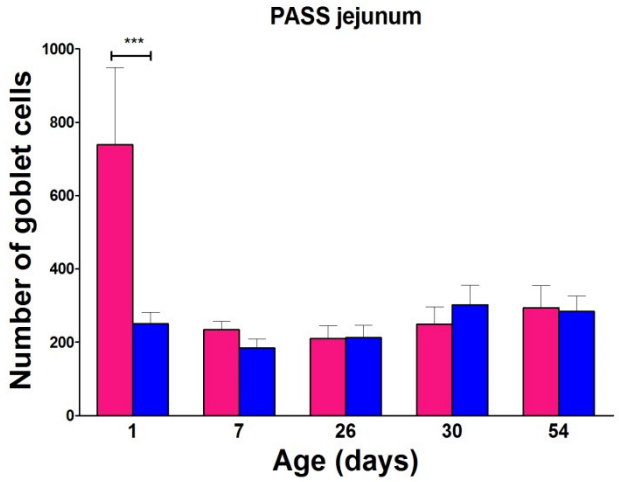
Parameters intestine piglets









Intestinal development offspring

Conclusions

- Transcriptional differences in offspring due to maternal feed intervention
- Transcriptional differences translates in intestinal cellular parameters
- Treatment of sows with amoxicillin leads to a difference in immune processes at day 1 with decreased number of goblet cells
- Treatment of sows with amoxicillin leads to difference apoptosis processes at weaning with an increase in crypt depth

Conclusion

- Treatment sows with amoxicillin no effect on performance piglets until day 42.
- Treatment of sows with amoxicillin has effect on microbiota and gene expression of piglets as measured
    - Either due to changes in microbiota composition of sows via vaginal microbiota or oral-fecal transmission.
- Possibility to modulate the intestinal development as well as microbiota of piglets by maternal feed intervention
- Follow up: determine correlation microbiota with gene expression

Credits

Central Veterinary Institute

- Mari Smits
- Astrid de Greeff
- Stéphanie Vastenhouw
- Alex Bossers
- Freddy de Bree
- Frank Harders
- Ralph Kok

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