Genetic Effects on Weight in Growing Piglets

(prae iPig project)

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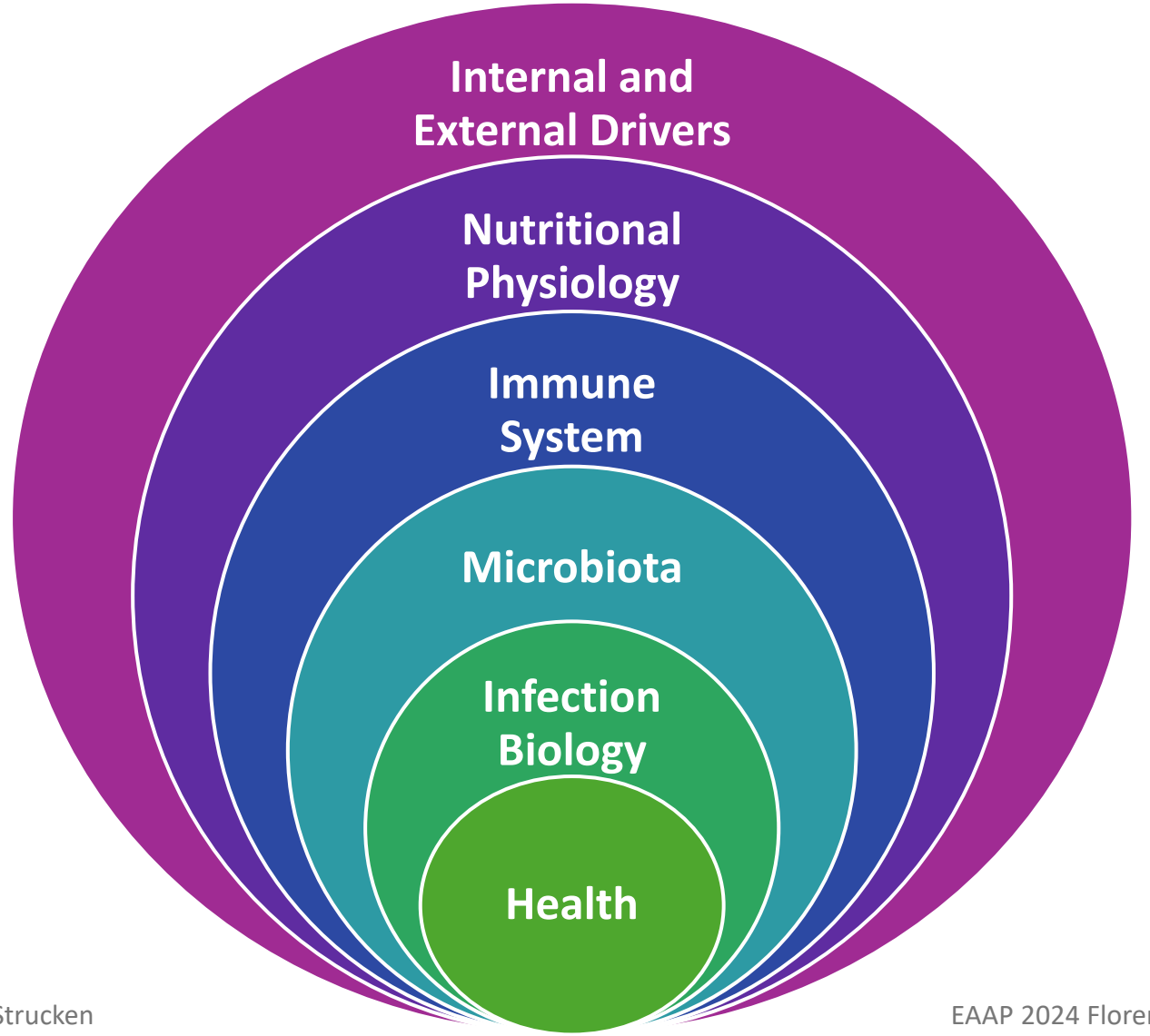
The prae iPig project

Introduction



Impact of dietary fiber

4 Feeding Groups (*ad libitum*)

- Coarse hay
- Fine hay
- Coarse sugar beet pulp
- Fine sugar beet pulp

C. Metges **Poster 89.29**
Impacts of feed on piglet plasma and digesta metabolite

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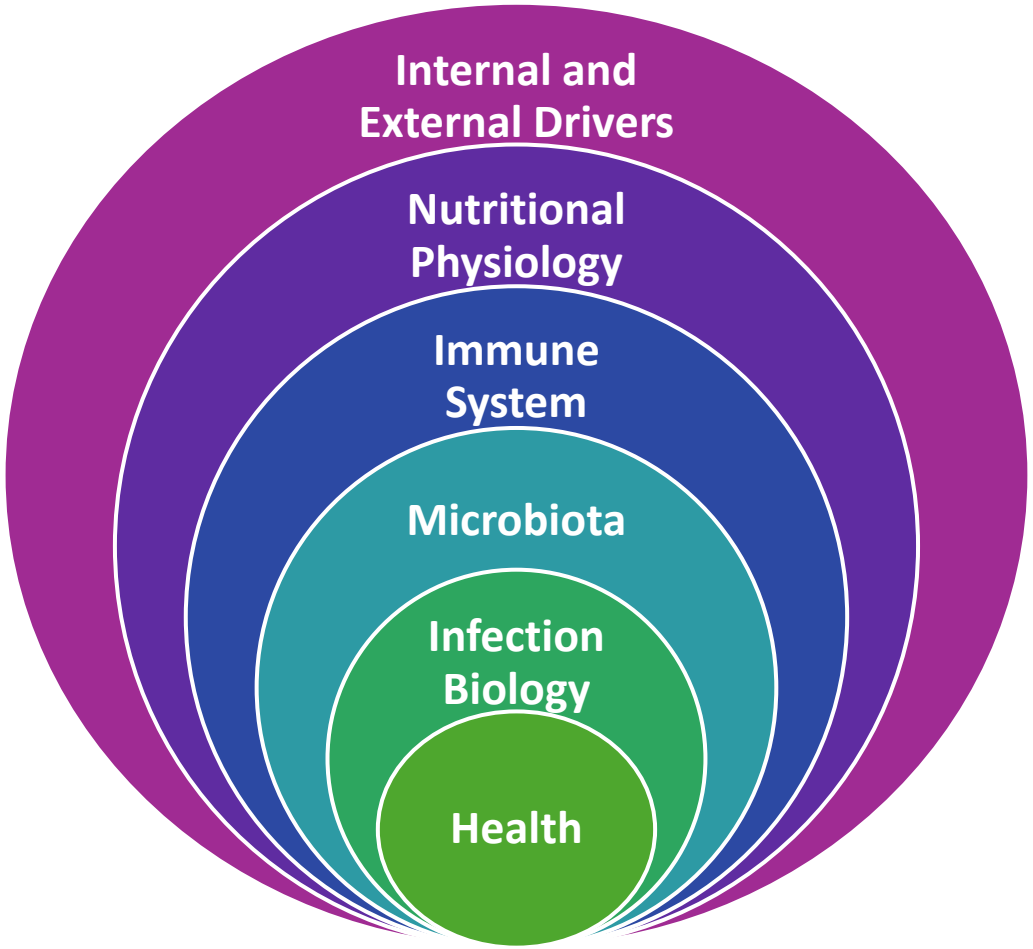

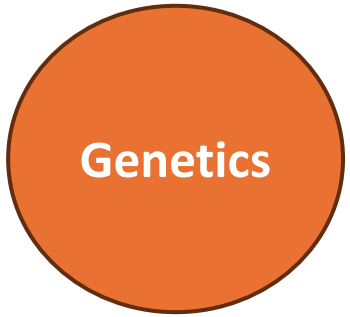

Impact of dietary fiber

4 Feeding Groups (*ad libitum*)

- Coarse hay
- Fine hay
- Coarse sugar beet pulp
- Fine sugar beet pulp

Are there genetic effects for piglet weight that can be associated to the different feed types?

C. Metges **Poster 89.29**
Impacts of feed on piglet plasma and digesta metabolite

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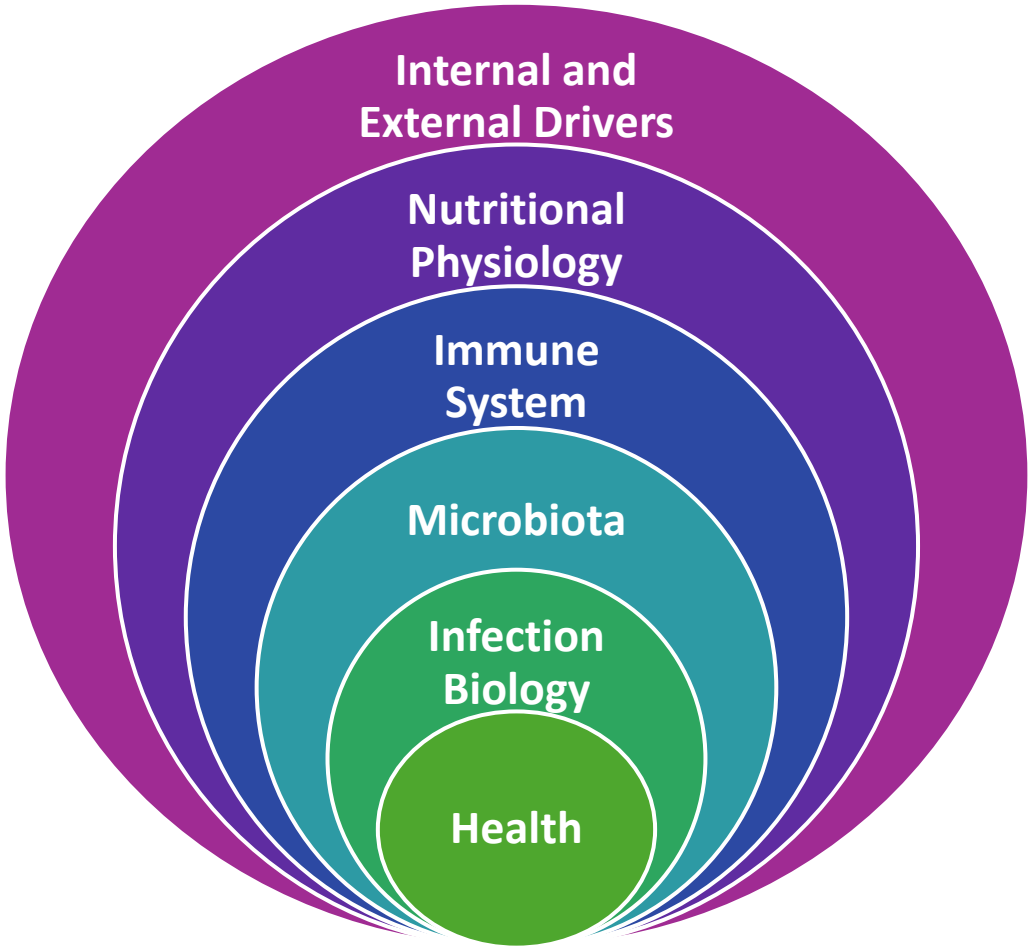
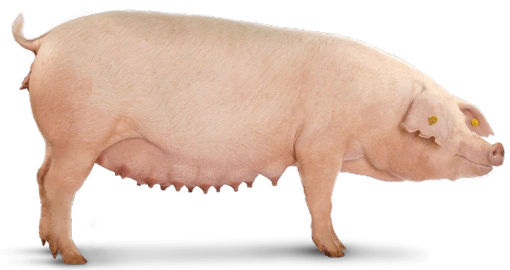
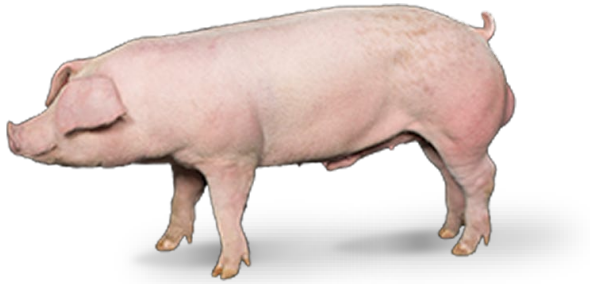
Material & Methods



German Landrace





21 sows **X** 8 boars

213 piglets

2 experiments

birth early November 2022 or mid January 2023

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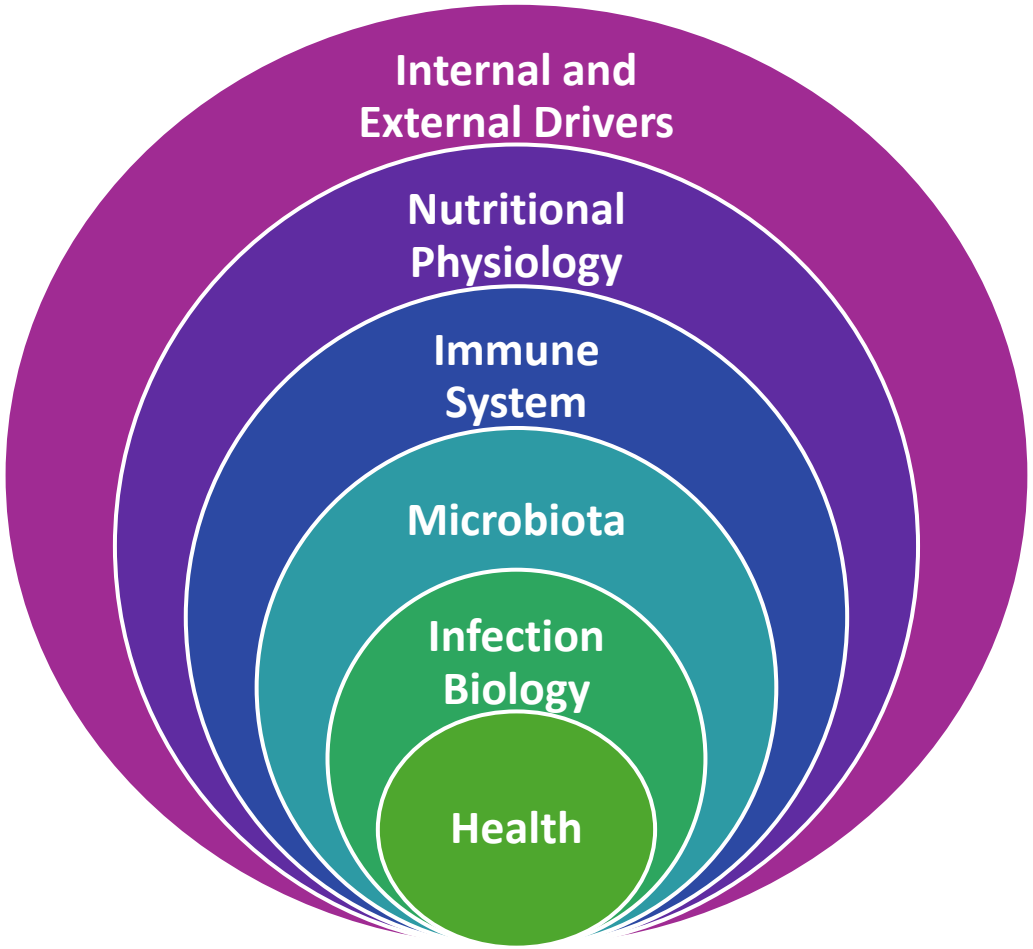
Material & Methods



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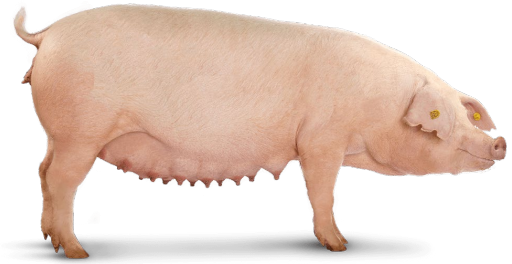


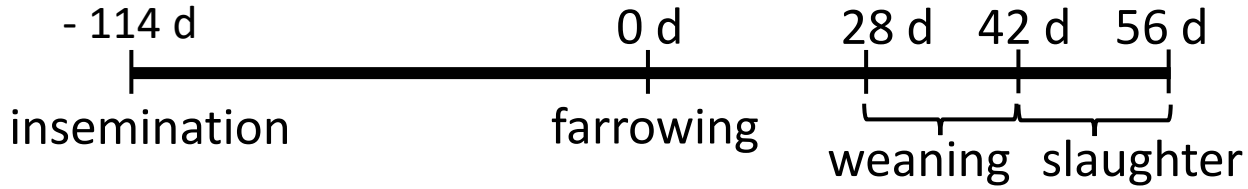
21 sows

213 piglets

4 Feeding Groups

- Coarse hay (n 4)
- Fine hay (n 6)
- Coarse sugar beet pulp (n 6)
- Fine sugar beet pulp (n 5)

- Creep feed
- 44 to 58 piglets per feeding group (sow)



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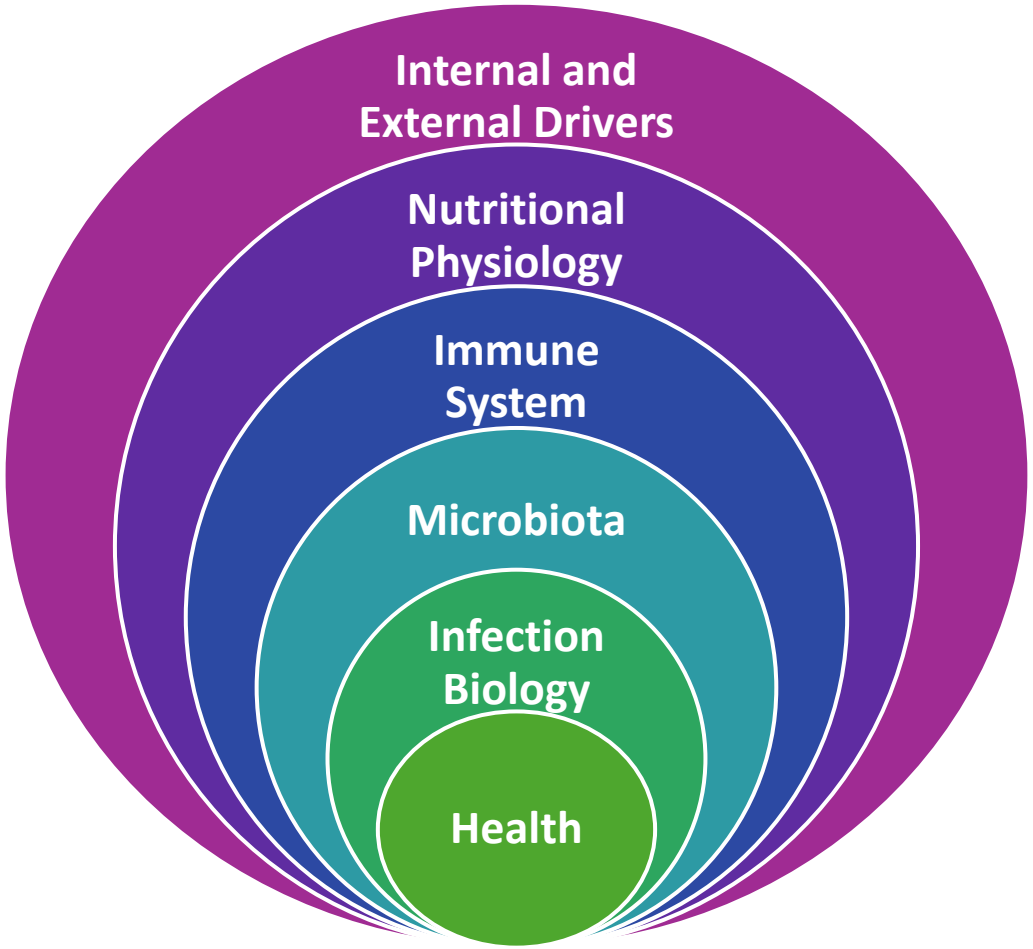
Material & Methods



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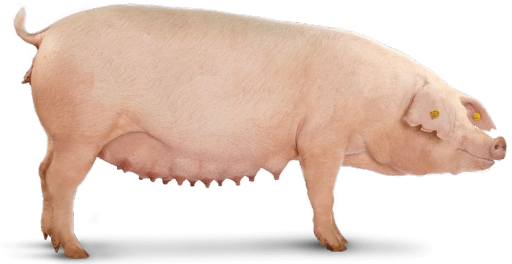

21 sows

213 piglets

Phenotypes Sows

- Weight (once per week)
- Short chain fatty acids
- Cortisol, CgA, Oxytocin,… (saliva)

Phenotypes Piglets

- **Weight** (birth, 3d, 7d, 14d,…56d)
- pH intestines
- Length and weight intestines
- SCFA
- Trace elements
- Cortisol, CgA, Oxytocin,… (saliva)

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Material & Methods

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Genetics

PorcineSNP80v1

75,753 SNPs
8 boars
21 sows
94 piglets

- GC score >70%
- Call rate >90%
- No unmapped, X, or Y
- 2 duplicated sows
- 1 piglet w/o genotype
- 1 piglet clustered with wrong family group
- 3 piglets where sow died after birth

47,745 SNPs
8 boars
21 sows
89 piglets

~ 22 piglets per feeding group

Power and Heritability

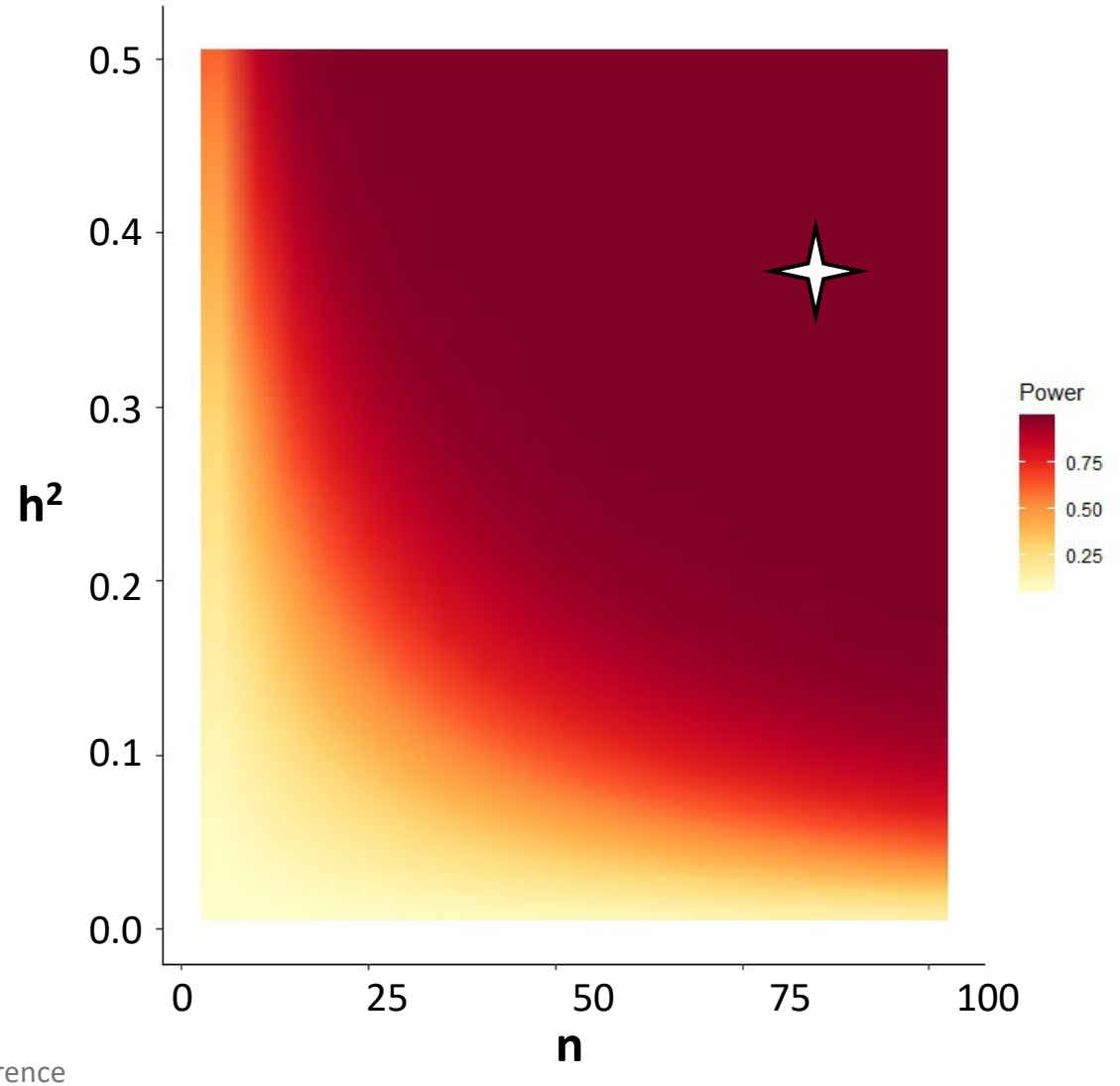
Material & Methods

Power

- 89 animals
- Power 0.8
- **h^2 > 0.09 needed**

Heritability

- Average Daily Weight Gain (ADG)
  - 0-21 days
  - ADG literature 0.22-0.58
  - **h^2: 0.38** (95% CI 0.29-0.48)*



*Gilmore et al. 1995, Kruijer et al. 2015

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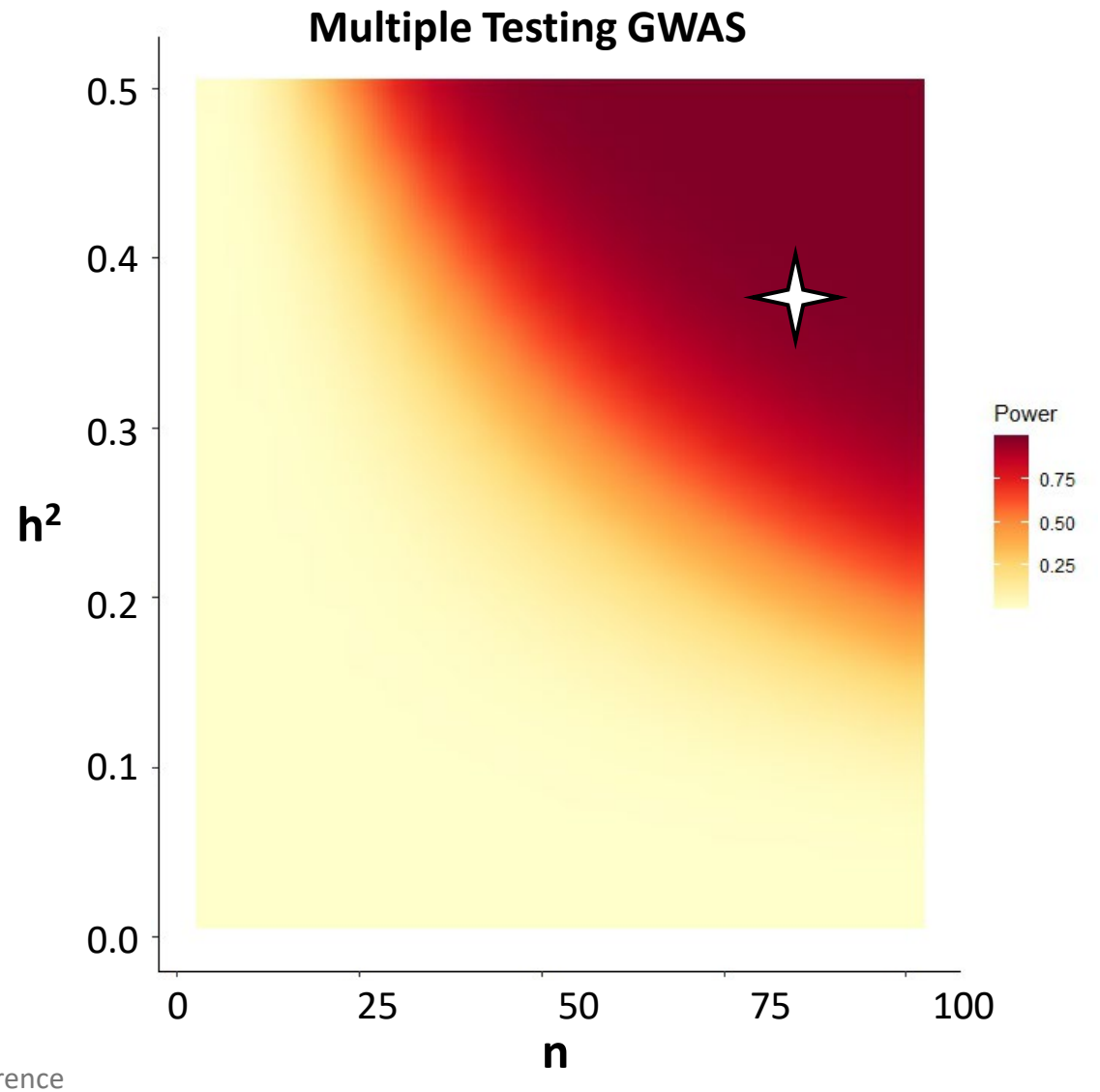
- Power 0.8
- h^2 > 0.38
- **55 animals**

Multiple Testing GWAS

*Gilmore et al. 1995, Kruijer et al. 2015



Environmental Effects

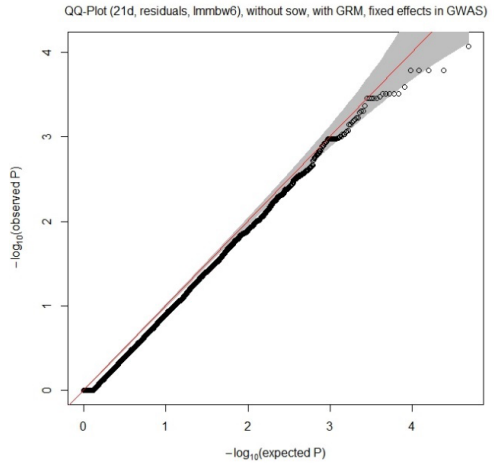
Material & Methods

y = **Feeding Group** + **Experiment** + Sex + SowBWgest + ADGSowsgest + LitterWeight + GestationDays +

SowBWlact + NbPiglets + BWGSows14d + Sow + e

y = Experiment + NbPiglets + Sow + e

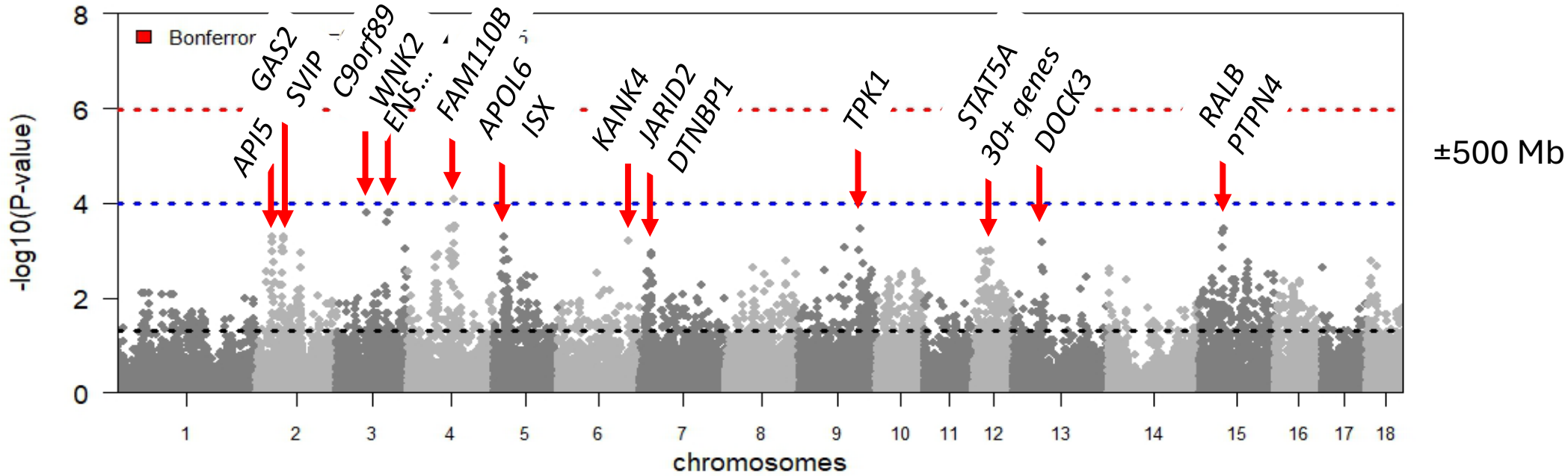
Genomic **R**elationship **M**atrix and fixed effects in a one step model



- SowBWgest: Sow body weight during gestation
- ADGSowsgest: average daily gain of sows during gestation
- Litter Weight
- Gestation Days
- SowBWlact: Sows body weight during lactation
- NbPiglets: number of piglets per litter
- BWGSows14d: body weight gain of sows during first 14 days after farrowing

GWAS – Average Daily Gain (0-21 days)

Results



Chr. 2: ***API5*** (*apoptosis inhibitor 5*)
GAS2 (*growth arrest specific 2*)
SVIP (*small VCP interacting protein*)

Chr.3: ***S9orf89***
WNK2 (*WNK lysine deficient protein kinase 2*)

Chr. 4: ***FAM110B***

Chr. 5: ***APOL6*** (*apolipoprotein L6*)
ISX (*intestine specific homeobox*)

Chr. 6: ***KANK4*** (*KN motif and ankyrin repeat domains 4*)

Chr. 7: ***JARID2*** (*jumonji and AT-rich interaction domain*)
DTNBP1 (*dystobrevin binding protein 1*)

Chr. 9: ***TPK1*** (*thiamin pyrophosphokinase 1*)

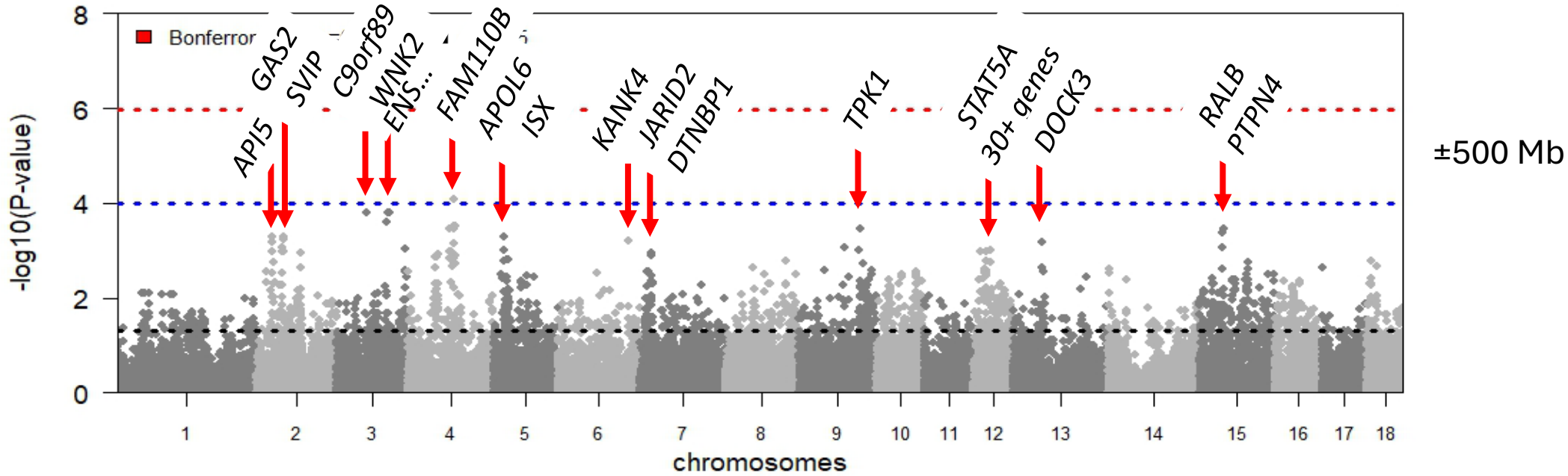
Chr. 12: ***STAT5A*** (*signal transducer and activator of transcription*)

Chr. 13: ***DOCK3*** (*dedicator of cytokinesis 3*)

Chr. 15: ***RALB*** (*RAS like proto-oncogene B*)
PTPN4 (*protein tyrosine phosphatse non-receptor type 4*)

GWAS – Average Daily Gain (0-21 days)

Results



Chr. 2: ***API5*** expressed in many types of tumors
GAS2 involved in cell cycle and apoptosis
SVIP linked to cancer progression

Chr.3: ***S9orf89***
WNK2 **involved in intracellular signalling**

Chr. 4: ***FAM110B***

Chr. 5: ***APOL6*** linked to cancer and apoptosis
ISX linked to cancer

Chr. 6: ***KANK4*** linked to cancer, developmental disorders

Chr. 7: ***JARID2*** linked to cancer, neurodevelopment
DTNBP1 linked to cancer and schizophrenia

Chr. 9: ***TPK1*** **movement disorders, dystonia**

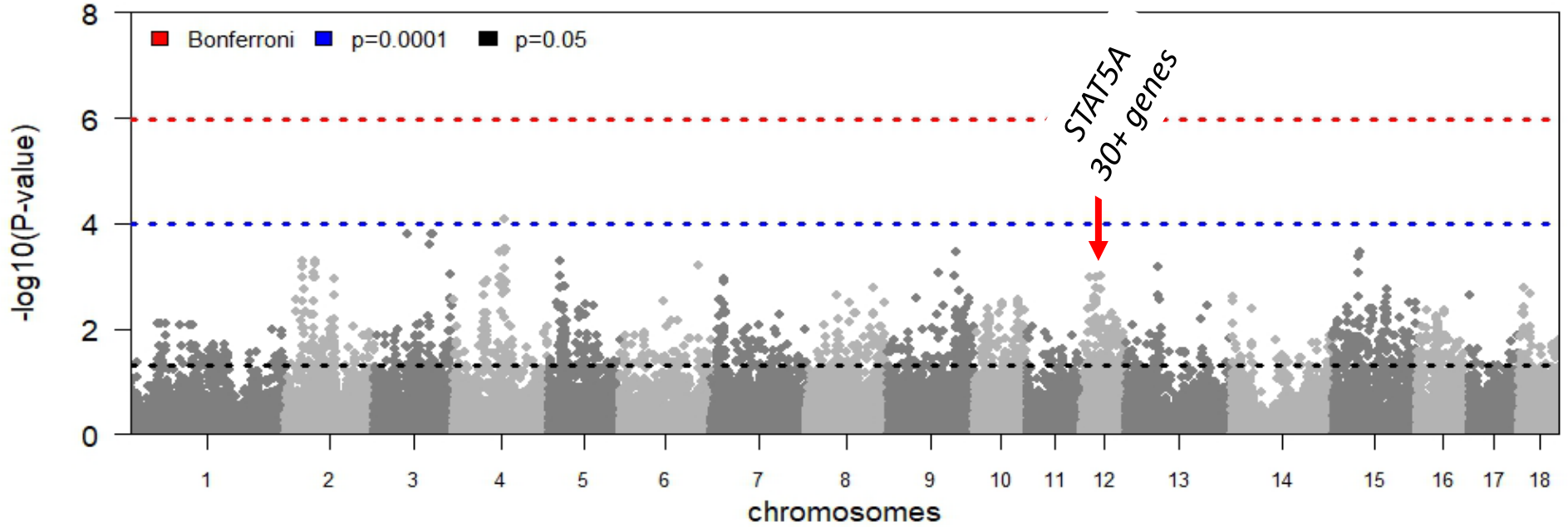
Chr. 12: ***STAT5A*** linked to cancer and immune diseases

Chr. 13: ***DOCK3*** **developmental delay, hypotonia**

Chr. 15: ***RALB*** linked to cancer, leukemia, autophagy
PTPN4 linked to cancer, HPV

GWAS – Average Daily Gain (0-21 days)

Results



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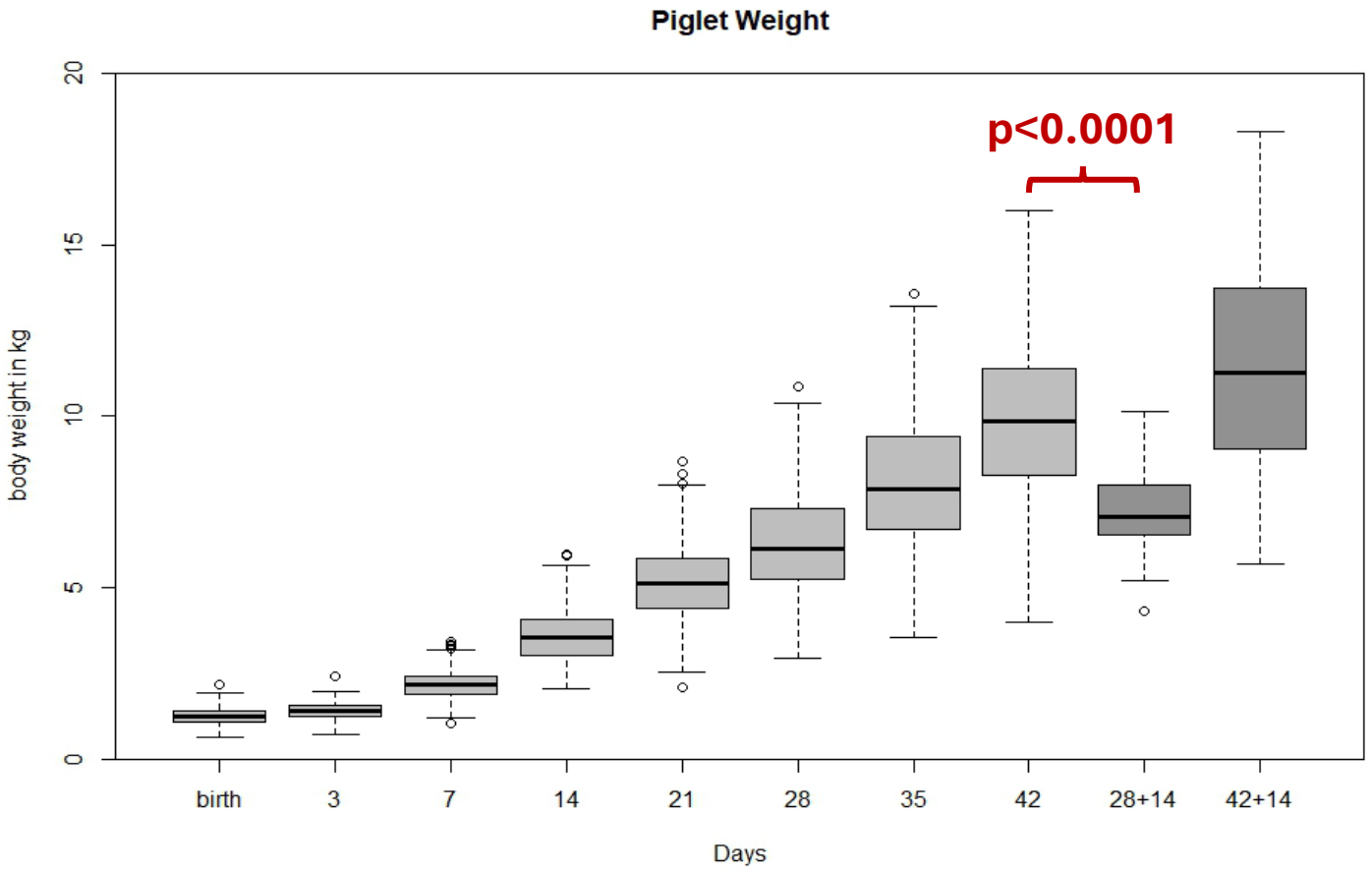
Chr. 6: ***KANK4***
Chr. 7: ***JARID2***
DTNBP1
Chr. 9: ***TPK1***
Chr. 12: ***STAT5A*** increases milk production in cattle
Chr. 13: ***DOCK3***
Chr. 15: ***RALB***
PTPN4

Weight after Weaning (28+14 days)

Results



Are there genetic effects associated with weight / weight loss at early weaning (28d)?

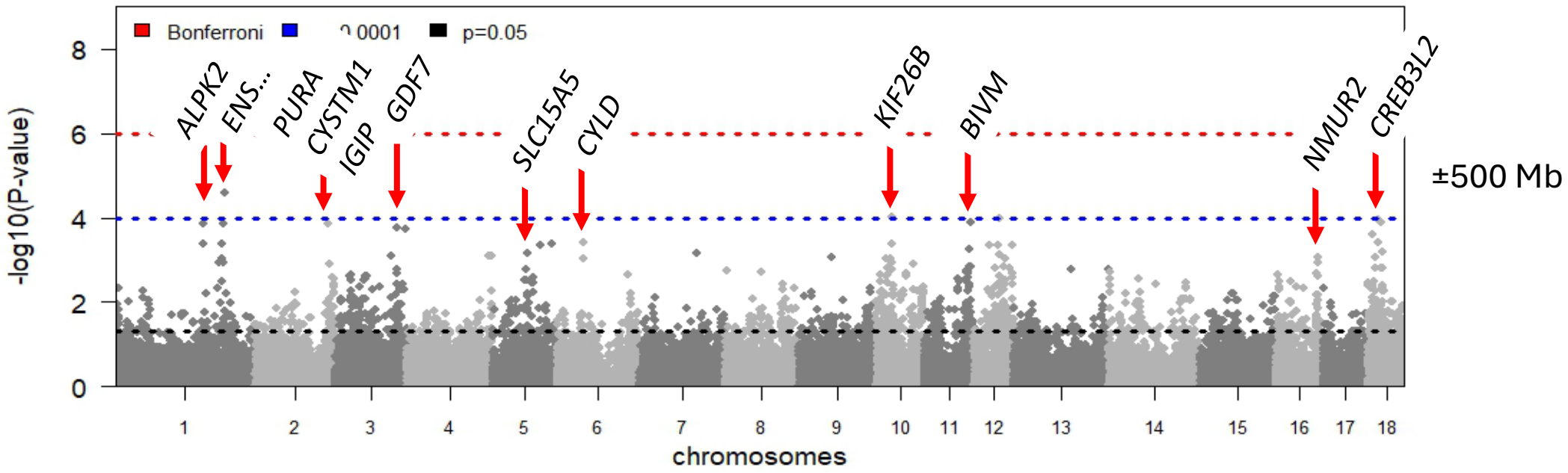
- 44 piglets **weaned at 28** days
- weighed at 42 days
- 2.69 kg difference to piglets **weaned at 42** days
- $h^2 = 0.08$

2 Stressors:

- Change in nutrition
- Removal from mother

GWAS – Weight after Weaning (28+14 days)

Results

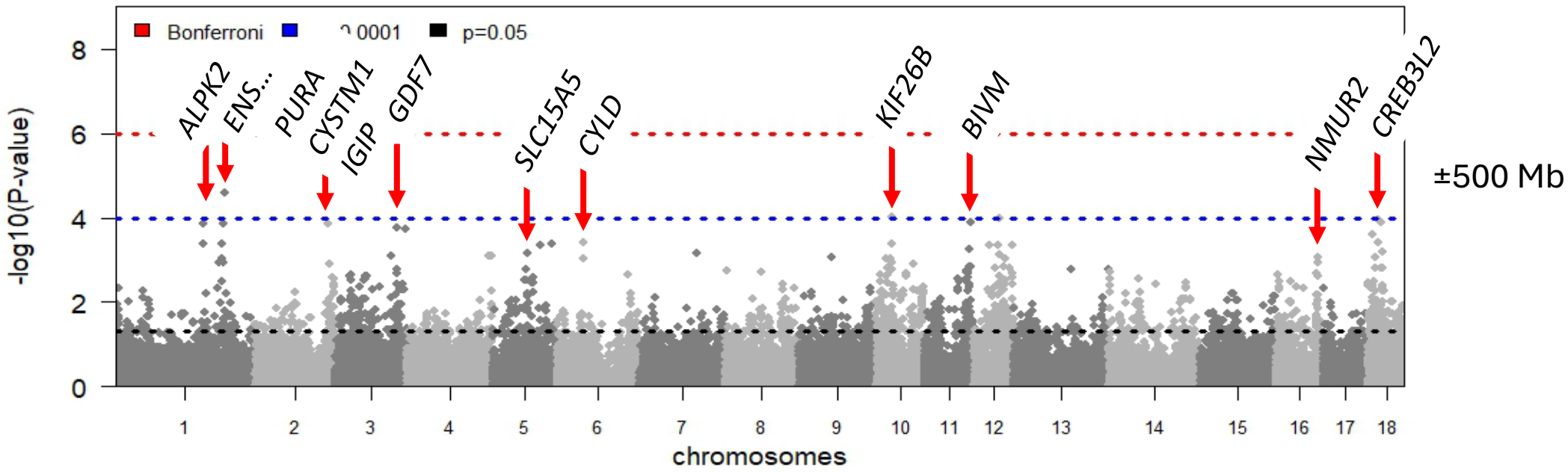


Chr. 1: ***ALPK2*** (*alpha kinase 2*)
Chr. 2: ***PURA*** (*Purine rich element binding protein A*)
CYSTM1 (*cysteine rich transmembrane module 1*)
IGIP (*IgA inducing protein*)
Chr. 3: ***GDF7*** (*growth differentiation factor 7*)
Chr. 5: ***SLC15A5*** (*solute carrier family 15 member 5*)

Chr. 6: ***CYLD*** (*CYLD lysine 63 deubiquitinase*)
Chr. 10: ***KIF26B*** (*kinesin family member 26B*)
Chr. 11: ***BIVM*** (*Basic, immunoglobulin-like variable motif*)
DTNBP1 (*dystrobrevin binding protein 1*)
Chr. 16: ***NMUR2*** (*neuromedin U receptor 2*)
Chr. 18: ***CREB3L2*** (*cAMP responsive element binding protein*)

GWAS – Weight after Weaning (28+14 days)

Results



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Chr. 1: ***ALPK2*** linked to renal and bladder cancer

Chr. 2: ***PURA*** **neuro/developmental disorders**

CYSTM1 **role in stress tolerance on cellular level**

IGIP **IgA response, increase in virus specific antibodies**

Chr. 3: ***GDF7*** **growth of sensory neurons, bone morphology**

Chr. 5: ***SLC15A5*** involved in peptide transport

Chr. 6: ***CYLD*** **inflamation response, cell survival and necrosis**

Chr. 10: ***KIF26B*** breast cancer, muscular atrophy

Chr. 11: ***BIVM*** bronchopulmonary dysplasia, schizophrenia

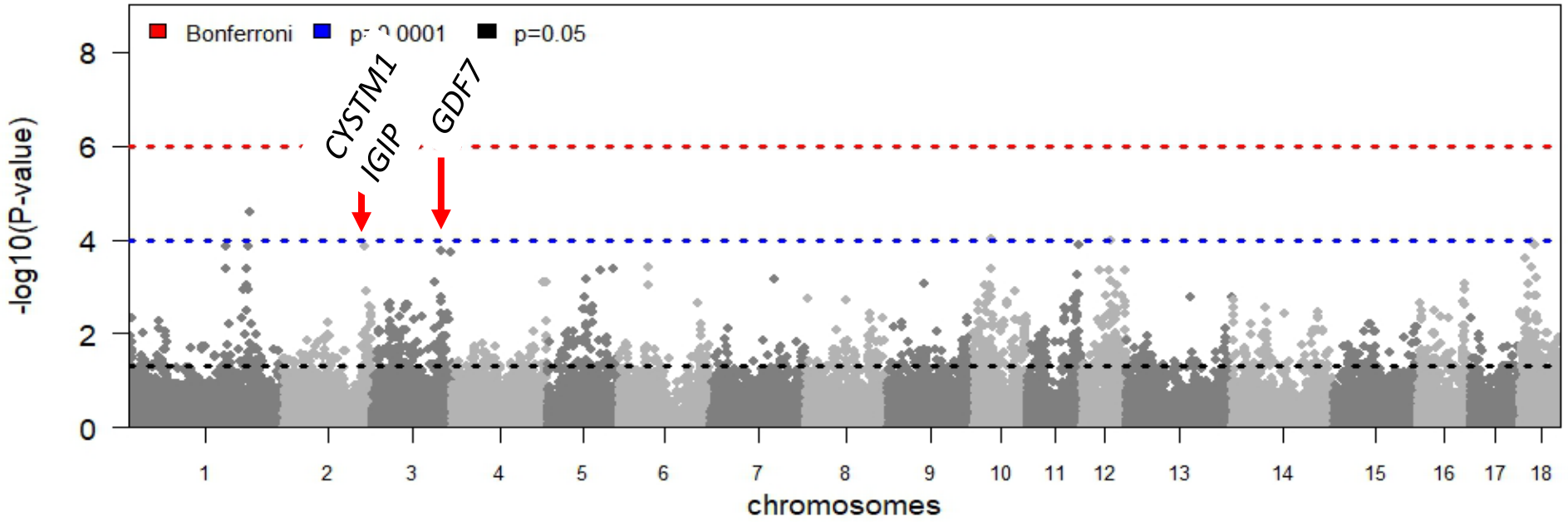
DTNBP1 linked to cancer and schizophrenia

Chr. 16: ***NMUR2*** **linked to asthma and COPD, obesity,** cancer

Chr. 18: ***CREB3L2*** linked to prostate cancer

GWAS – Weight after Weaning (28+14 days)

Results



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Chr. 1: ***ALPK2***

Chr. 2: ***PURA***

CYSTM1 **role in stress tolerance on cellular level**

IGIP **IgA response, increase in virus specific antibodies**

Chr. 3: ***GDF7*** **growth of sensory neurons, bone morphology, dental development**

Chr. 5: ***SLC15A5***

Summary and Conclusion

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Average Daily Gain (ADG)

- No effect of feeding groups on ADG
- No significant genetic effects, but several distinct peak regions

Weight after Weaning (28+14 days)

- **Piglets should be kept with their mothers for longer**
- No significant genetic effects, but several promising peak regions
- *IGIP* (*IgA inducing protein*) plays a pivotal role in host defense through mucus secretion (Austin et al. 2003)
- *CYSTM1* (*cysteine-rich transmembrane module 1*) cysteine-rich transmembrane module with a role in stress tolerance

Outlook

- We need a larger sample size to find significant genome-wide effects
- Whole genome-sequences should also improve the detection of genetic effects and discovery of specific causal allele variants

Thank you for your attention!

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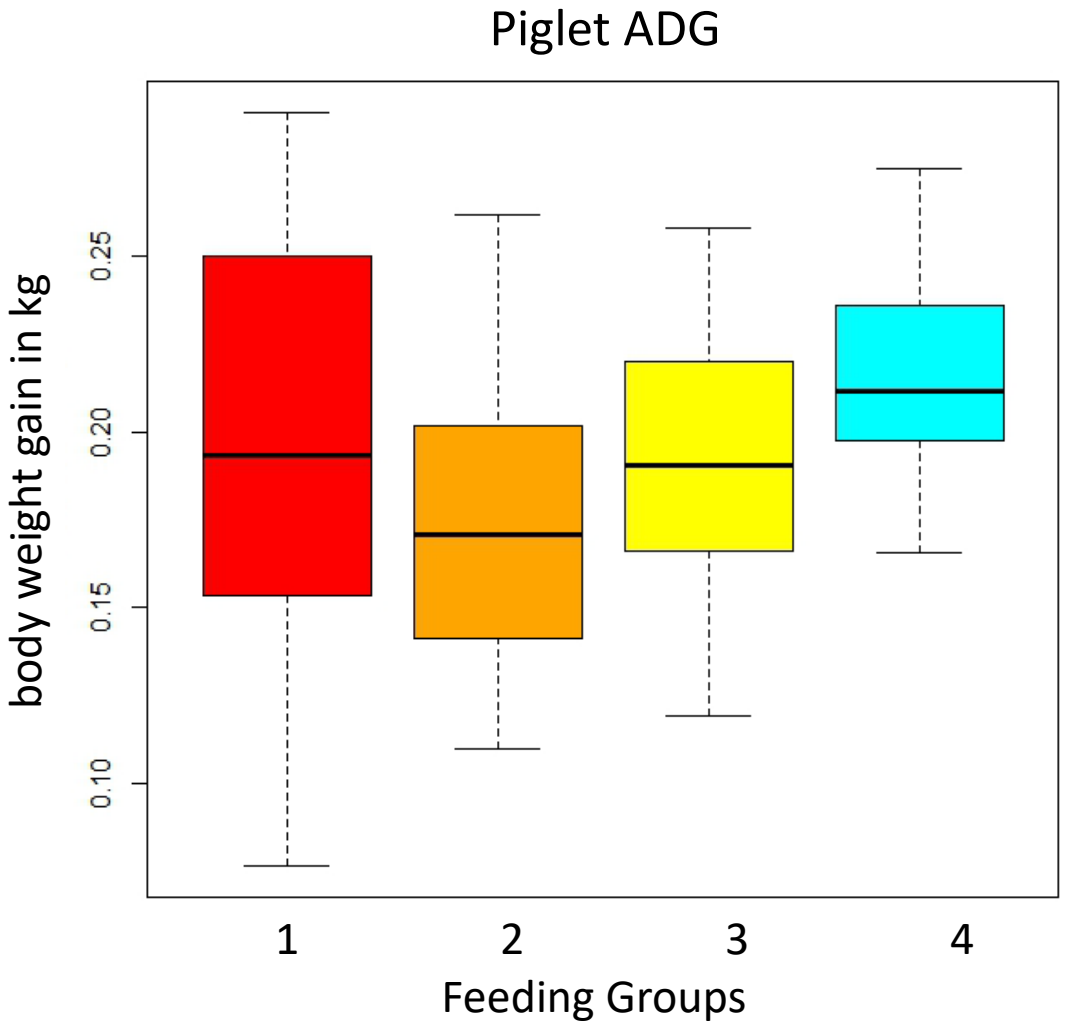
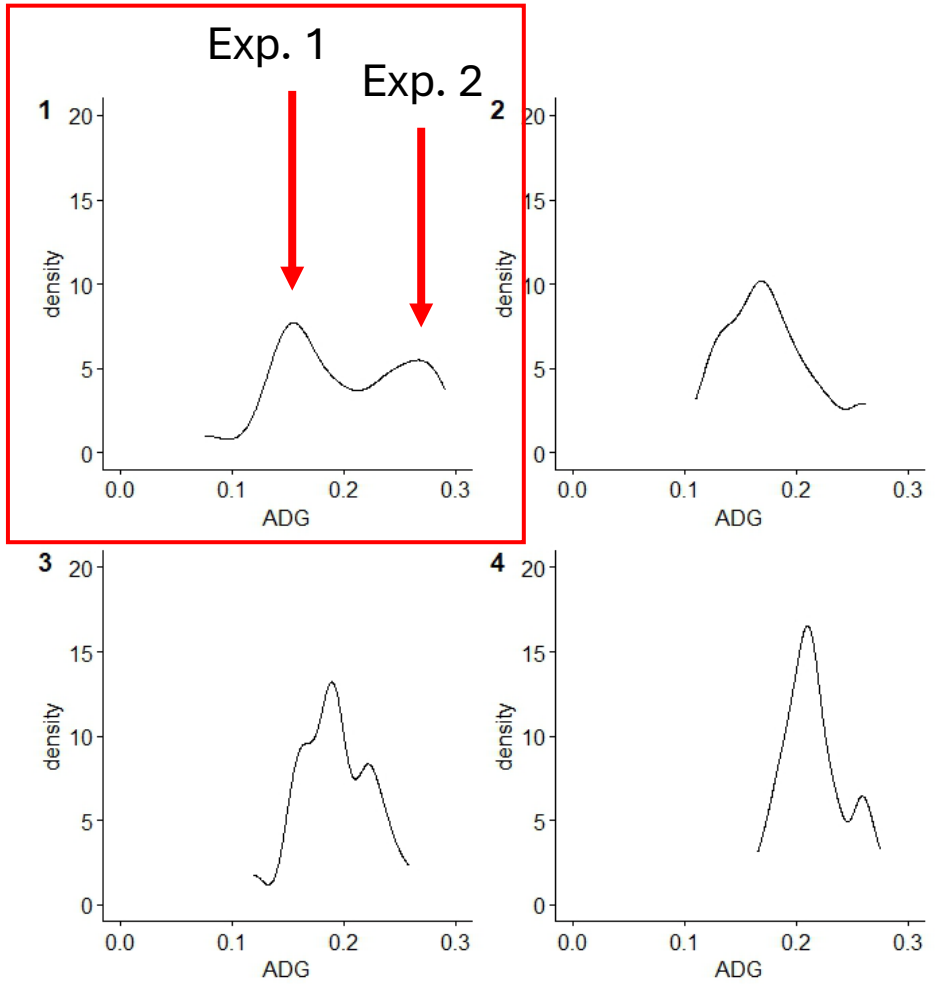
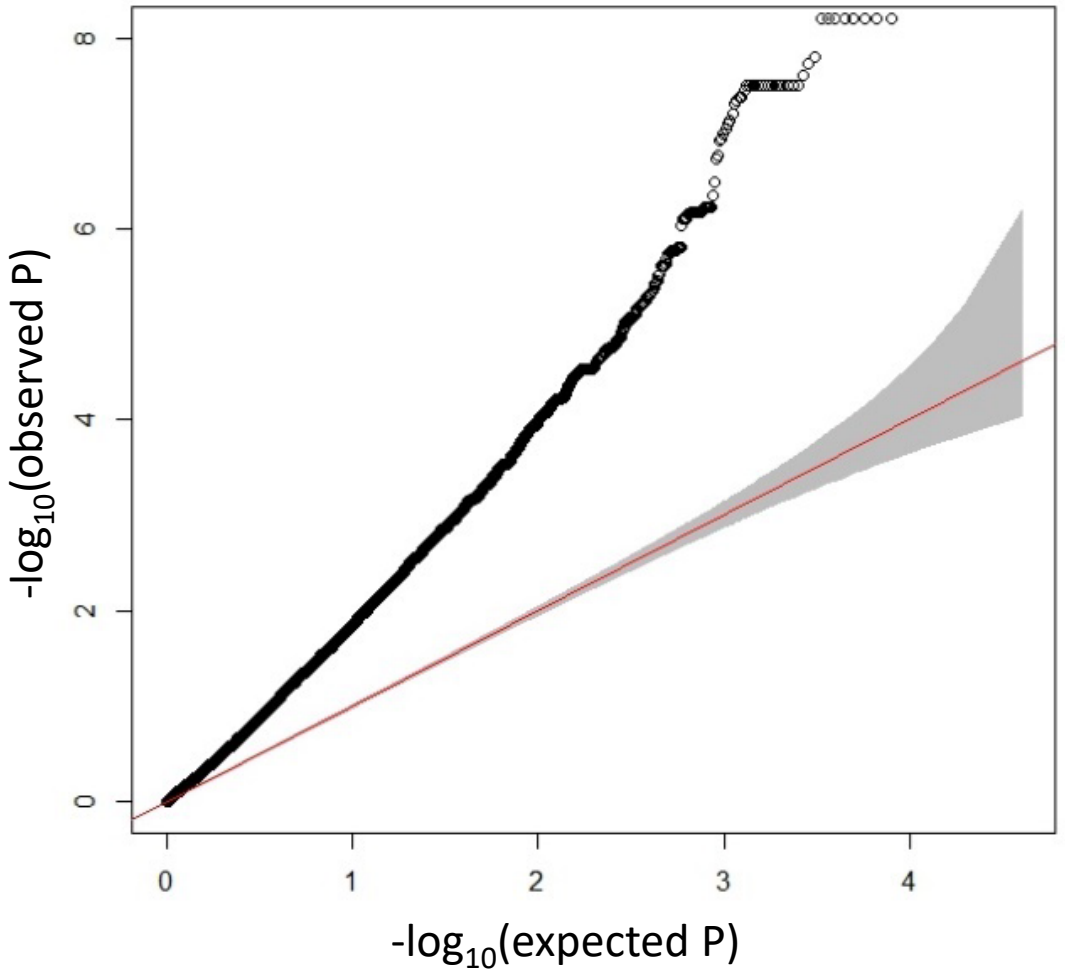




Genetic Effects

Material & Methods

QQ plot – **No correction** for population stratification



QQ plot – **G**enomic **R**elationship **M**atrix and **fixed effects**