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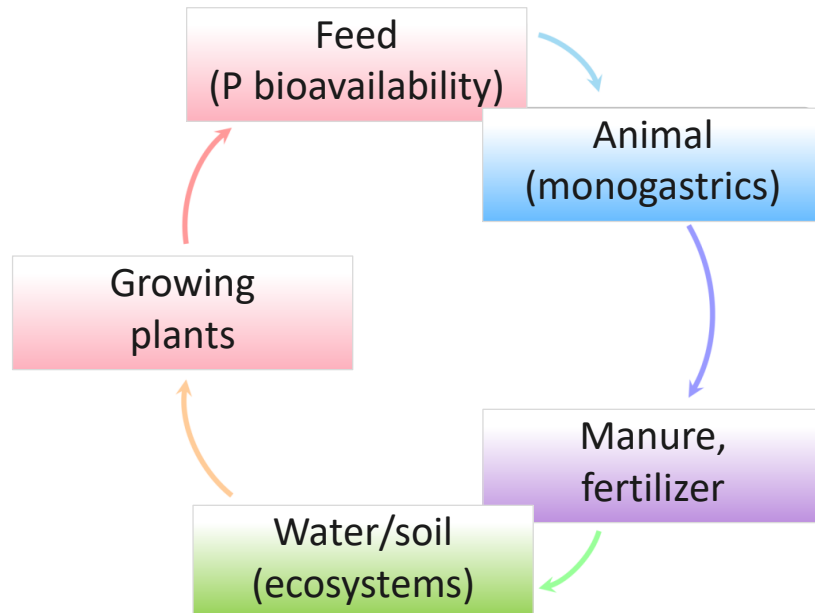
In the framework of the PEGaSus project:

# **Molecular drivers of the phosphorus (P) homeostasis in pigs**

Henry Reyer, Michael Oster, Dörte Wittenburg, Eduard Muráni, Siriluck Ponsuksili, Klaus Wimmers

Leibniz Institute for Farm Animal Biology (FBN Dummerstorf, Germany)

# Bridging the gaps in the agricultural P cycle

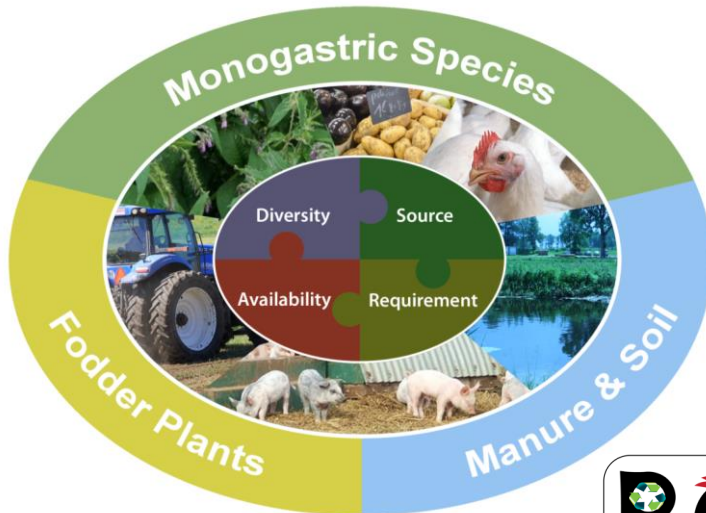


- ▶ Consistent and efficient usage of P in animal husbandry
- ▶ Improve the endogenous mechanisms of P utilization in pigs & poultry
  - Diets (P supply, P source)
  - Animals (genetics)

# Bridging the gaps in the agricultural P cycle

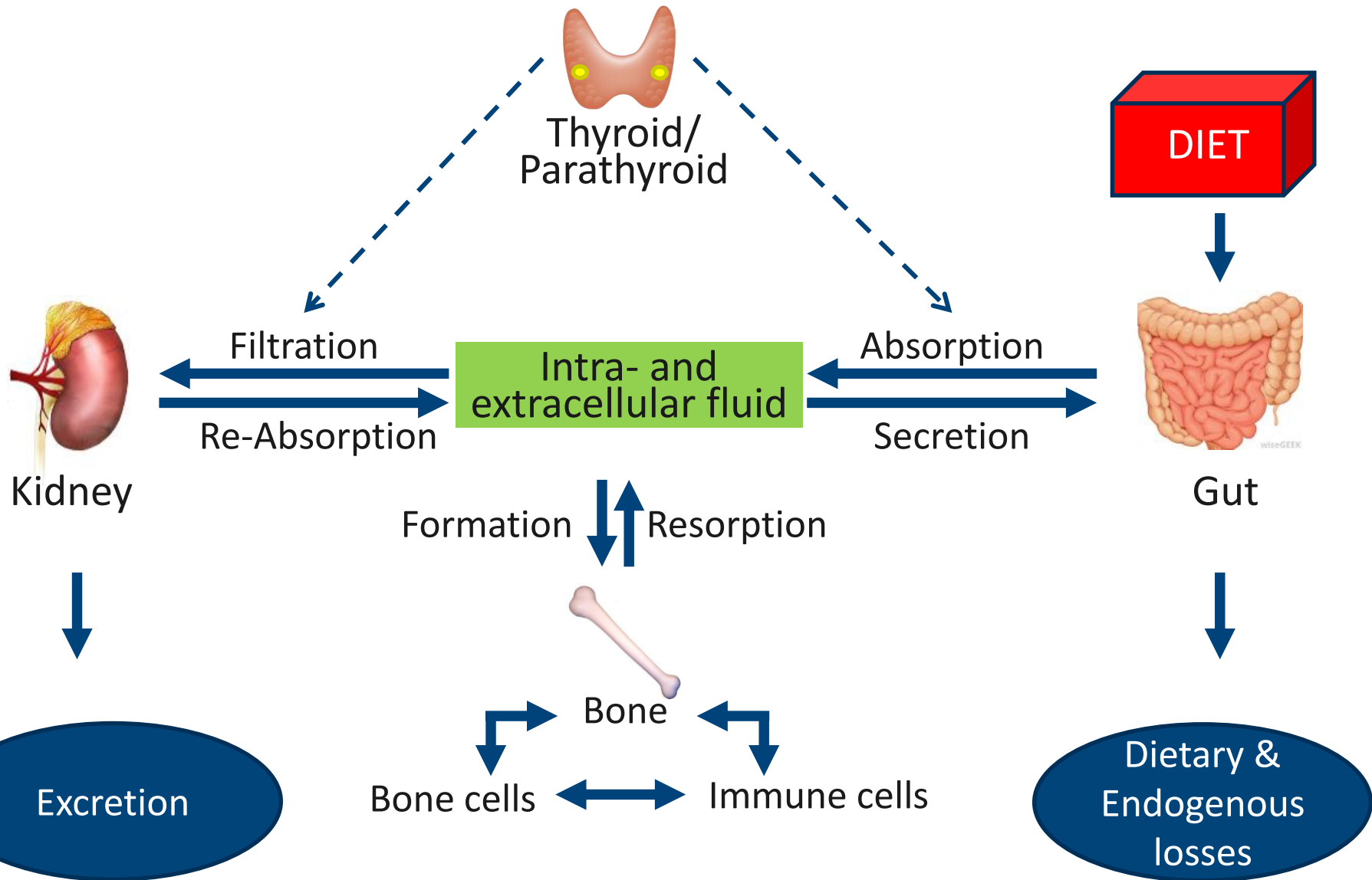


Oster et al., *Sustainability* **2018**, 10, 1825



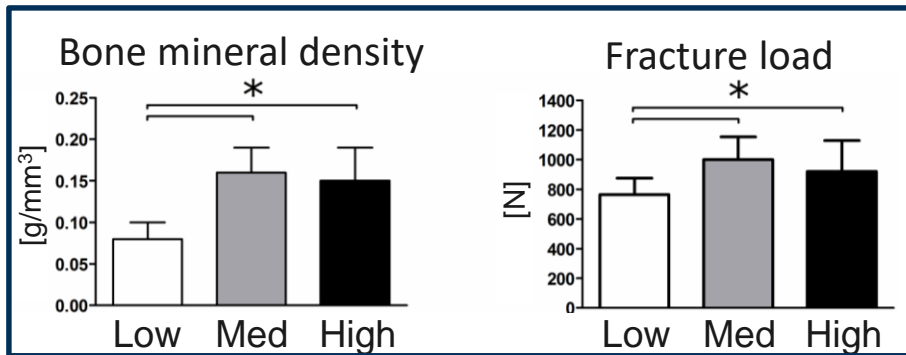
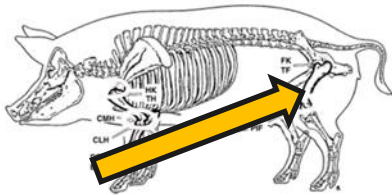
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# Map of the phosphorus (P) homeostasis



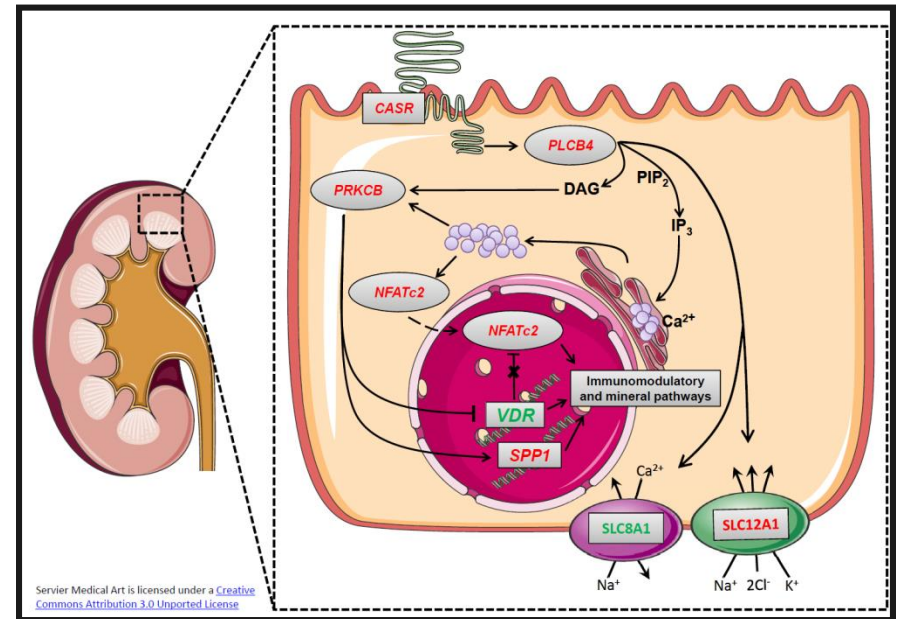
# Dietary mineral supply impacts on bone structure and immune cascades

Gerlinger et al., *Nutrients* **2019**, 11:436



- Susceptibility of trabecular bone to dietary challenges (p<0.05)

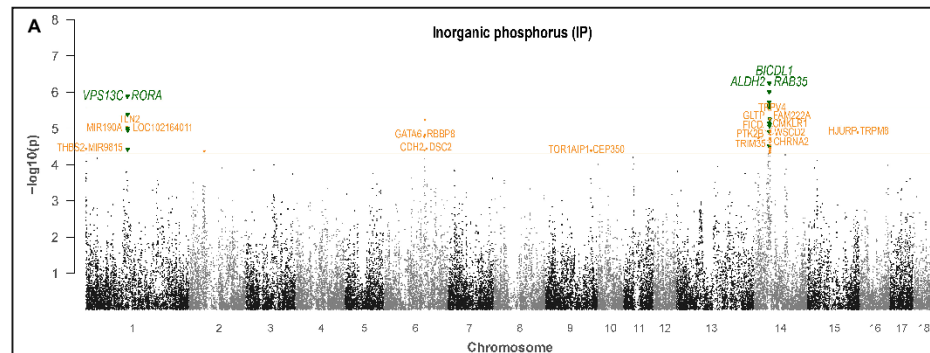
Just et al., *BMC Genomics* **2018**, 19, 207



- Molecular links between mineral homeostasis and adaptive immunity

# Genetic Contribution to Variation in Blood Calcium, Phosphorus, and Alkaline Phosphatase Activity in Pigs

Reyer et al.,  **frontiers in Genetics**, 2019, 10, 590

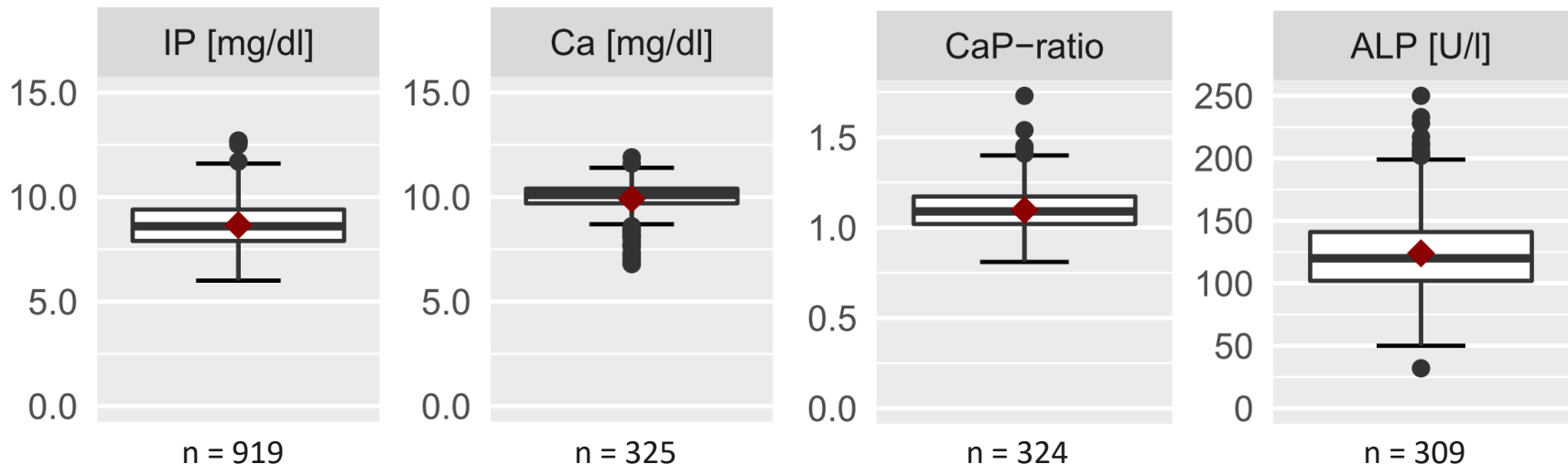


- Analysis of genomic heritability estimates and phenotypic correlations
- Detection of QTL regions
- Identification of putative candidate genes

# Analysed animals

- Population of German Landrace pigs slaughtered at FBN
- Specifications:
  - 923 animals (males, female, castrates)
  - 60K chip genotypes
  - average age of  $162 \pm 15$  days
  - blood levels measured with FUJI DRI-CHEM

IP – Inorganic phosphorus  
Ca – Calcium  
Ca:P – Ca-IP ratio  
ALP – Alkaline phosphatase



# Results: Genetic parameters

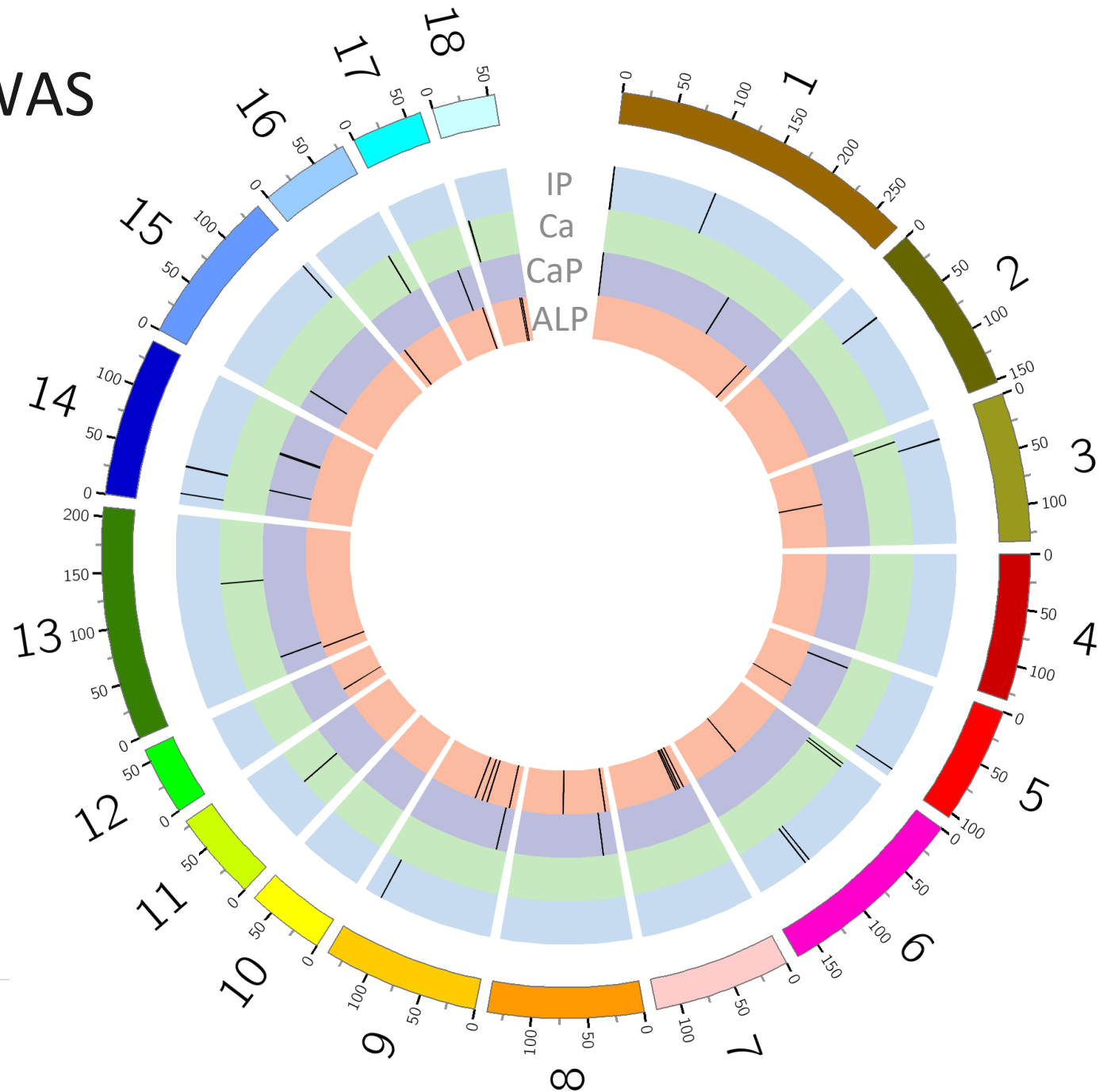


Estimates of **genetic** (below diagonal) and **phenotypic** (above diagonal) correlation and **genomic heritability** (diagonal)

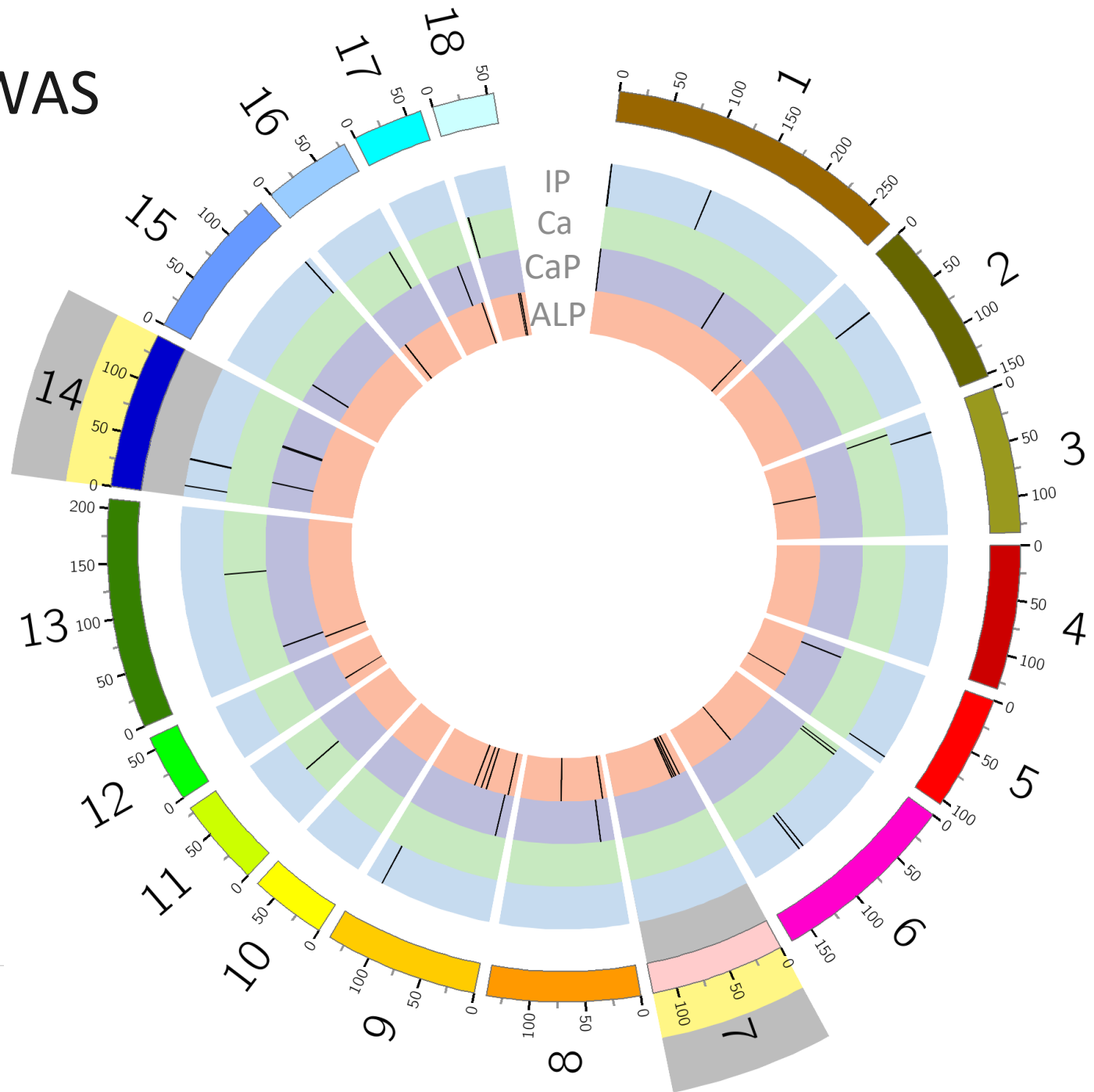
Trait	IP	Ca	ALP	Ca/P
IP	<b><math>0.42 \pm 0.05</math></b>	0.26	0.14	-0.75
Ca	0.23 $\pm$ 0.22	<b><math>0.27 \pm 0.07</math></b>	0.11	0.40
ALP	0.06 $\pm$ 0.20	-0.16 $\pm$ 0.21	<b><math>0.54 \pm 0.08</math></b>	-0.03
Ca/P	-0.62 $\pm$ 0.13	0.29 $\pm$ 0.20	-0.21 $\pm$ 0.20	<b><math>0.27 \pm 0.07</math></b>

- Moderate genomic heritability for all traits
- Heritability estimates for IP and ALP higher than for Ca and Ca:P
- Considerable genetic contribution to the variation in blood levels

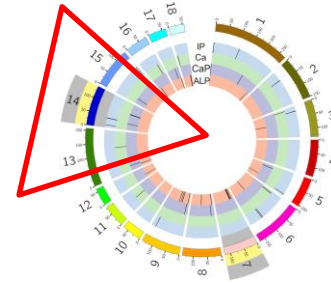
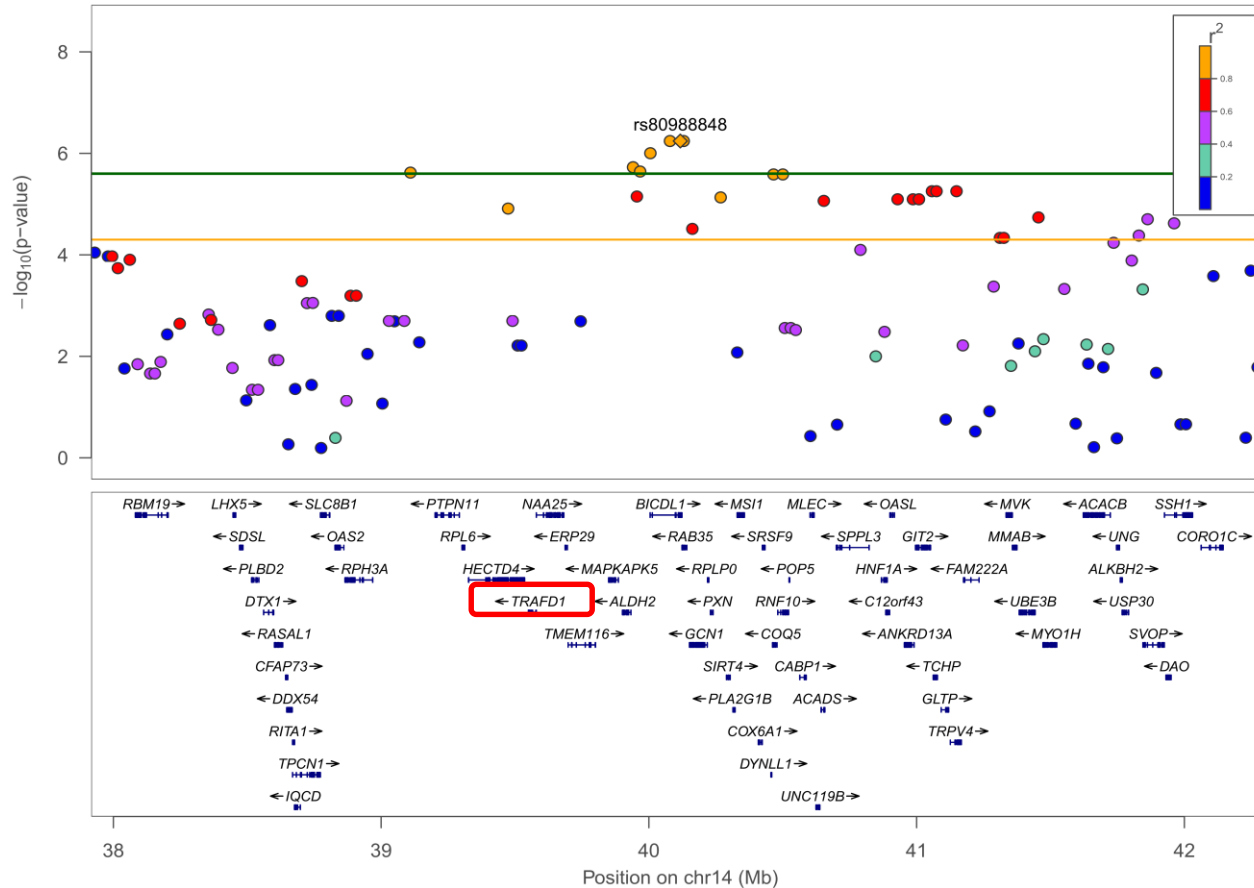
# Results: GWAS



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# Zoom into the QTL on chromosome 14 for IP in pigs

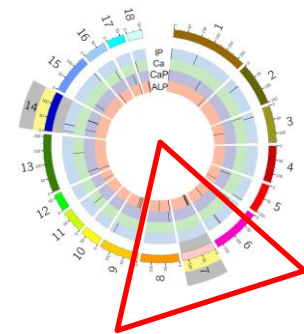
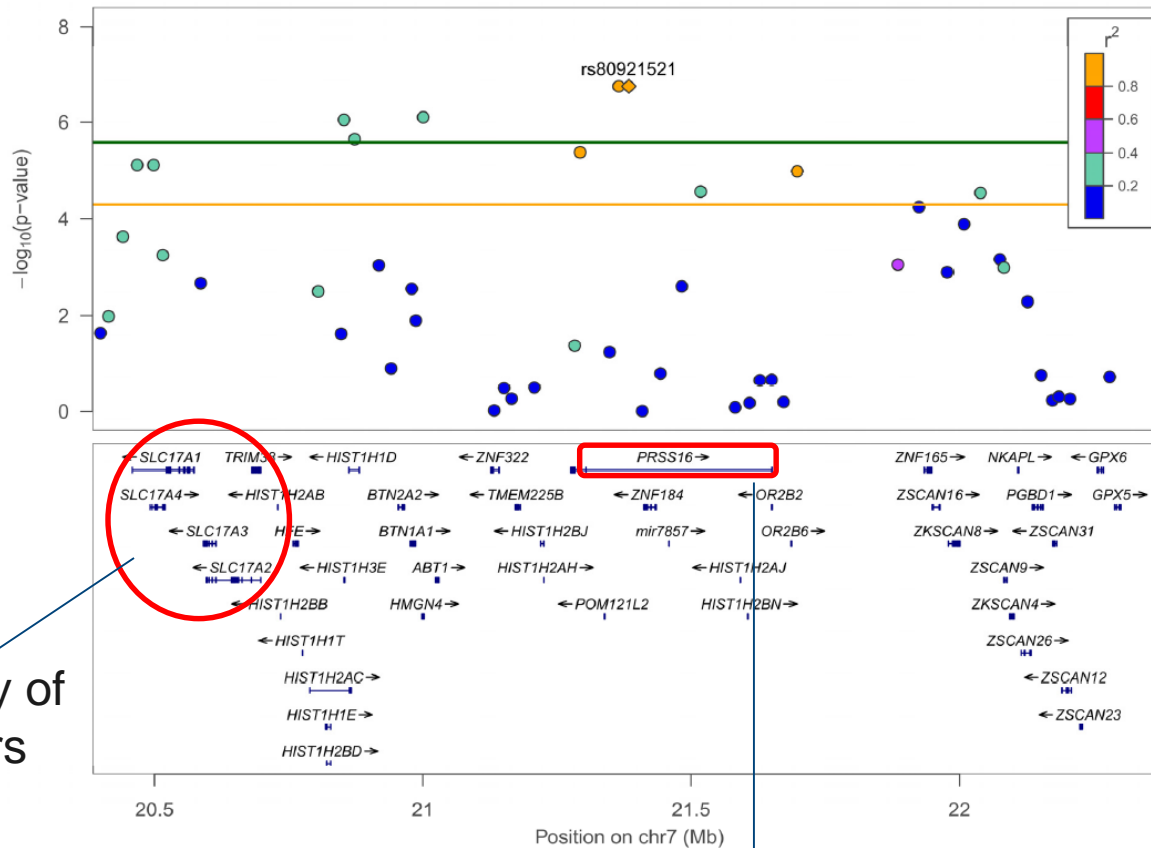


Strong LD in this QTL with several putative candidates e.g. *TRAFD1*

## TRAF-Type Zinc Finger Domain Containing 1

- Important for resorbing and secretory activities of osteoclasts
- Negative feedback regulator controlling excessive immune responses

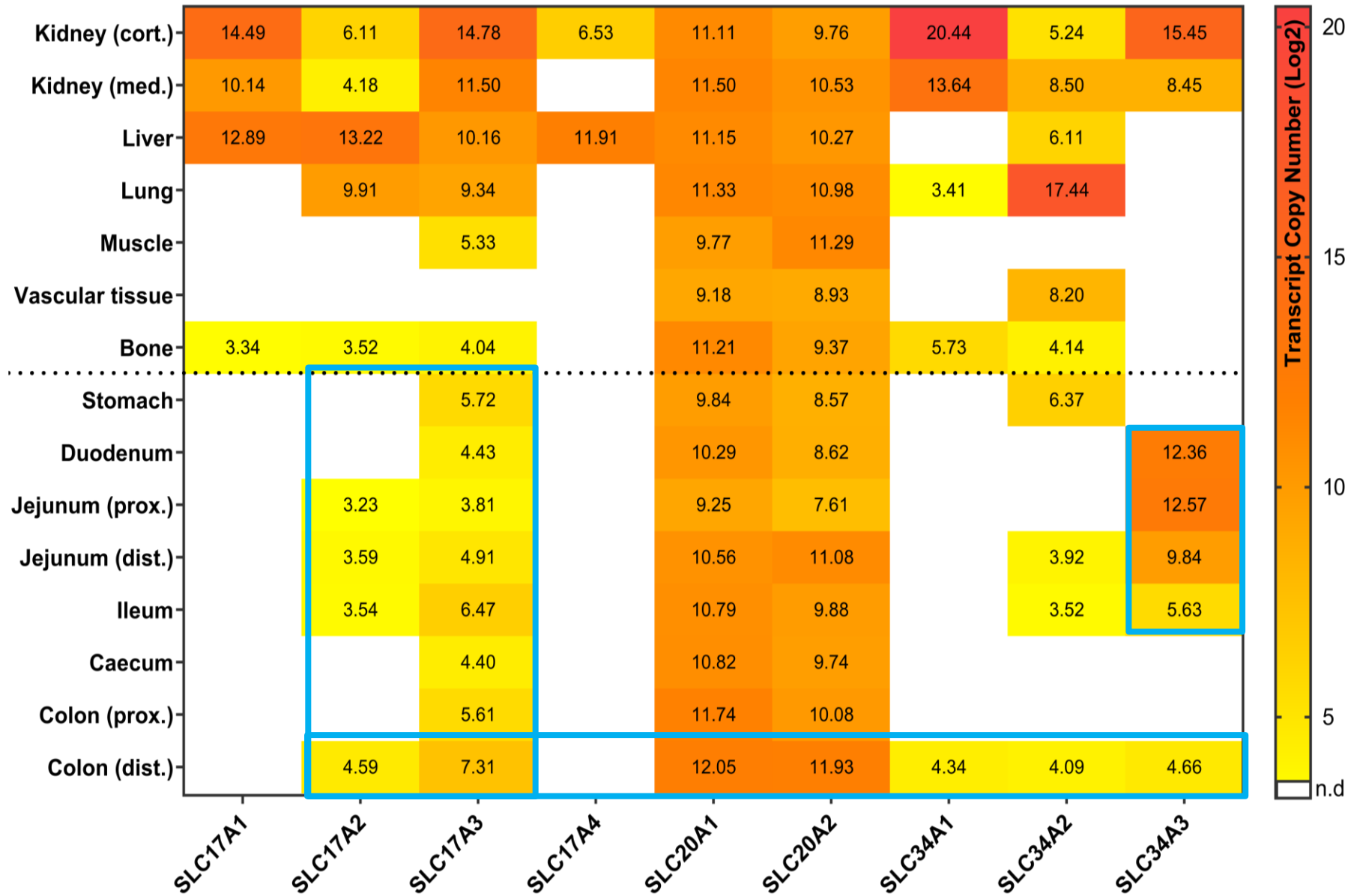
# Zoom into the QTL on chromosome 7 for ALP in pigs



SLC17 family of  
P transporters

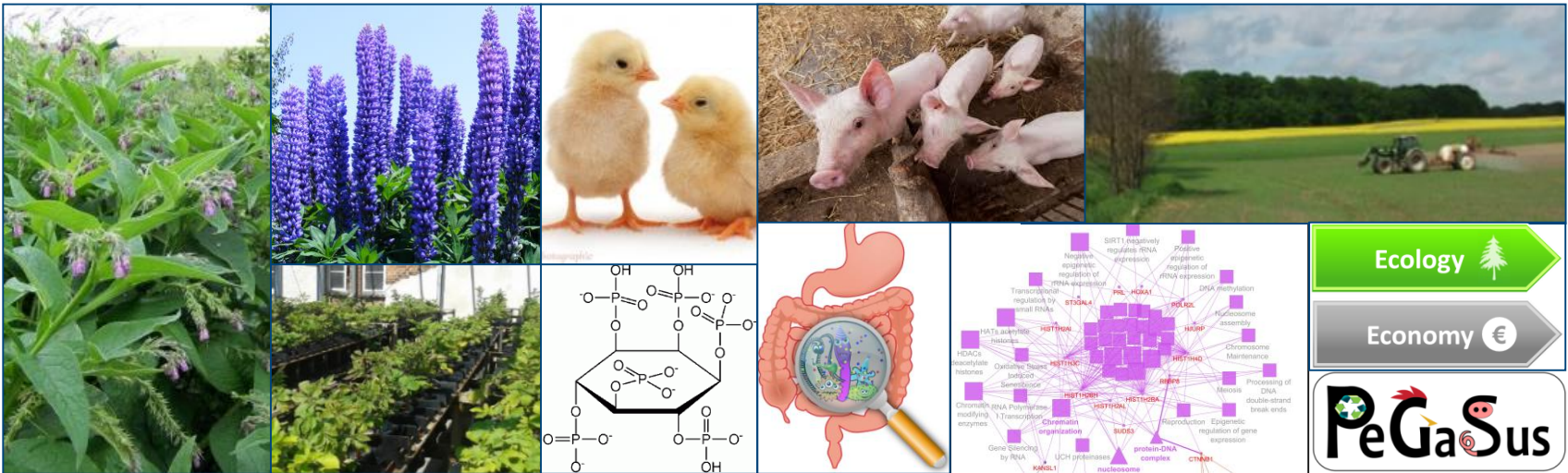
*PRSS16*: Serine Protease acting in T-cell development and antigen-presenting pathways

# Expression profile of porcine sodium/P transporters



# Expected outcome and impact of PEGaSus

- ▶ Beside management strategies (P supply, P sources), animal intrinsic factors need to be considered



- ▶ Variation between pigs in terms of P utilization, which could be exploited (e.g. microbiota, (epi)genetics, gene expression)
- ▶ Assessment of economic gains, reuse options, and impact of political constraints

Partners:



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Funders:



ERA-NET **SUSAN**



Federal Ministry  
of Food  
and Agriculture



Forskningssrådet  
Formas



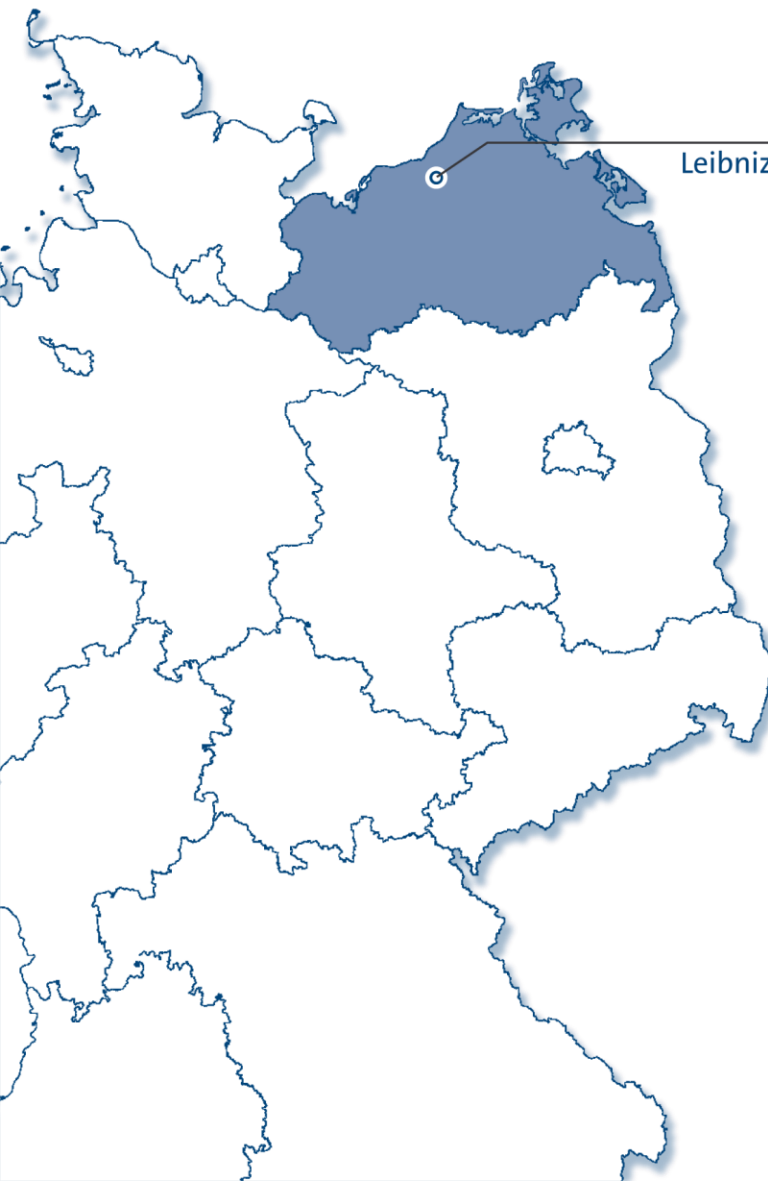
Ministry of Environment  
and Food of Denmark  
The Danish Agrifish Agency

**mipaaf**  
ministero delle  
politiche agricole  
alimentari e forestali





**LEIBNIZ INSTITUTE**  
FOR FARM ANIMAL BIOLOGY



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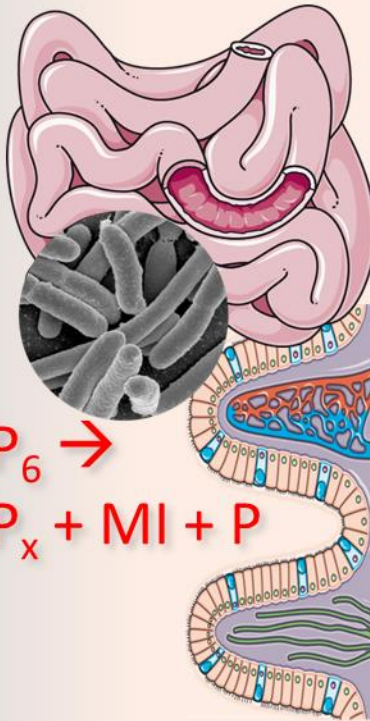
Internet: [www.fbn-dummerstorf.de](http://www.fbn-dummerstorf.de)

exogenous

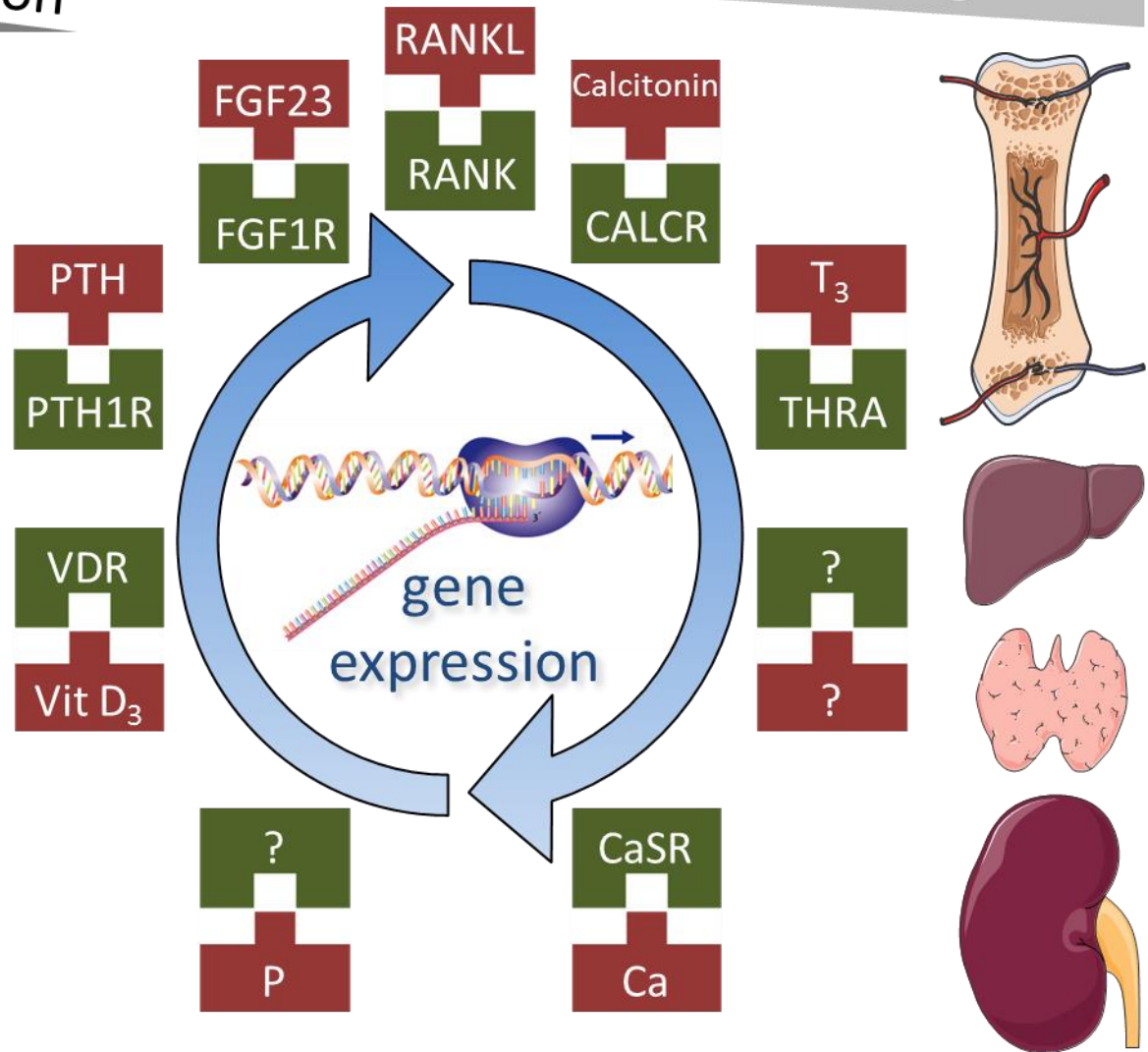
interaction

endogenous

Nutrition  
InsP<sub>6</sub> & P



InsP<sub>6</sub> →  
InsP<sub>x</sub> + MI + P



endocrine & paracrine regulation, signalling