BIOFRACTAL
GENES INTO ACTION

anh-innovation
Customer-driven innovation in animal nutrition and health

Using gene expression to understand problems and solutions of poultry production

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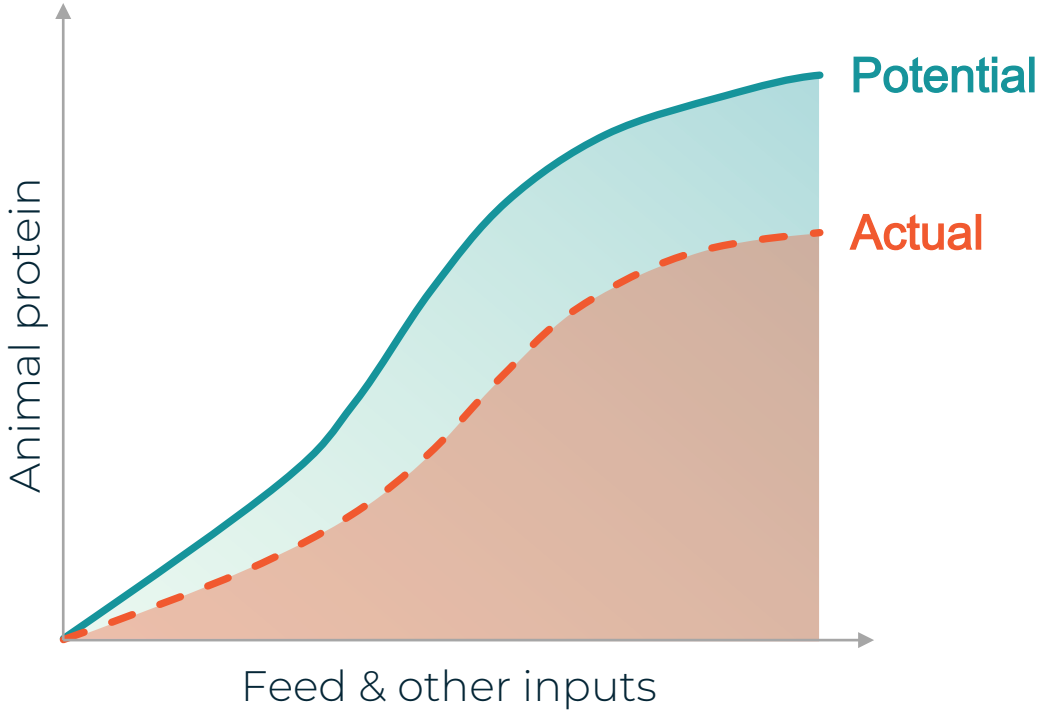
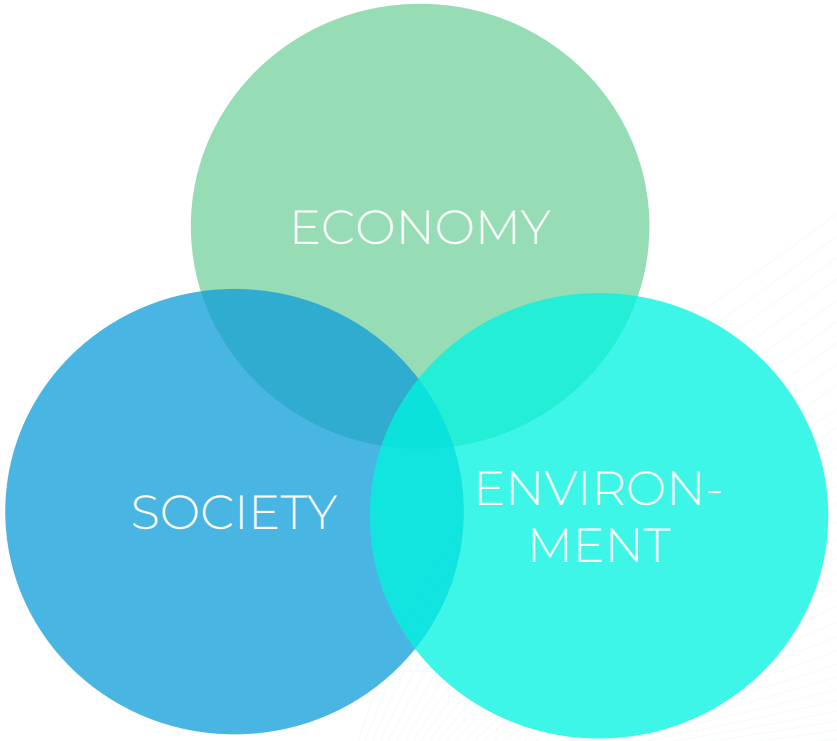
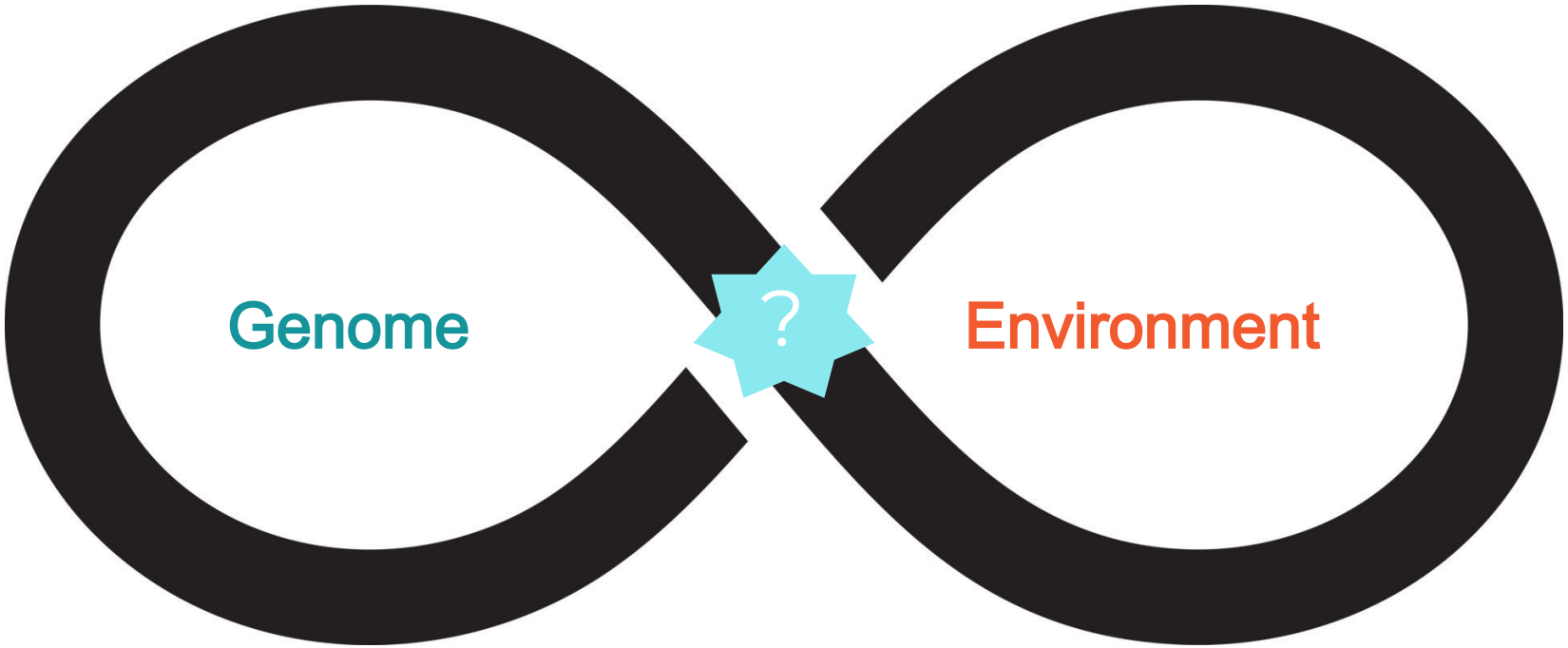
January 2023

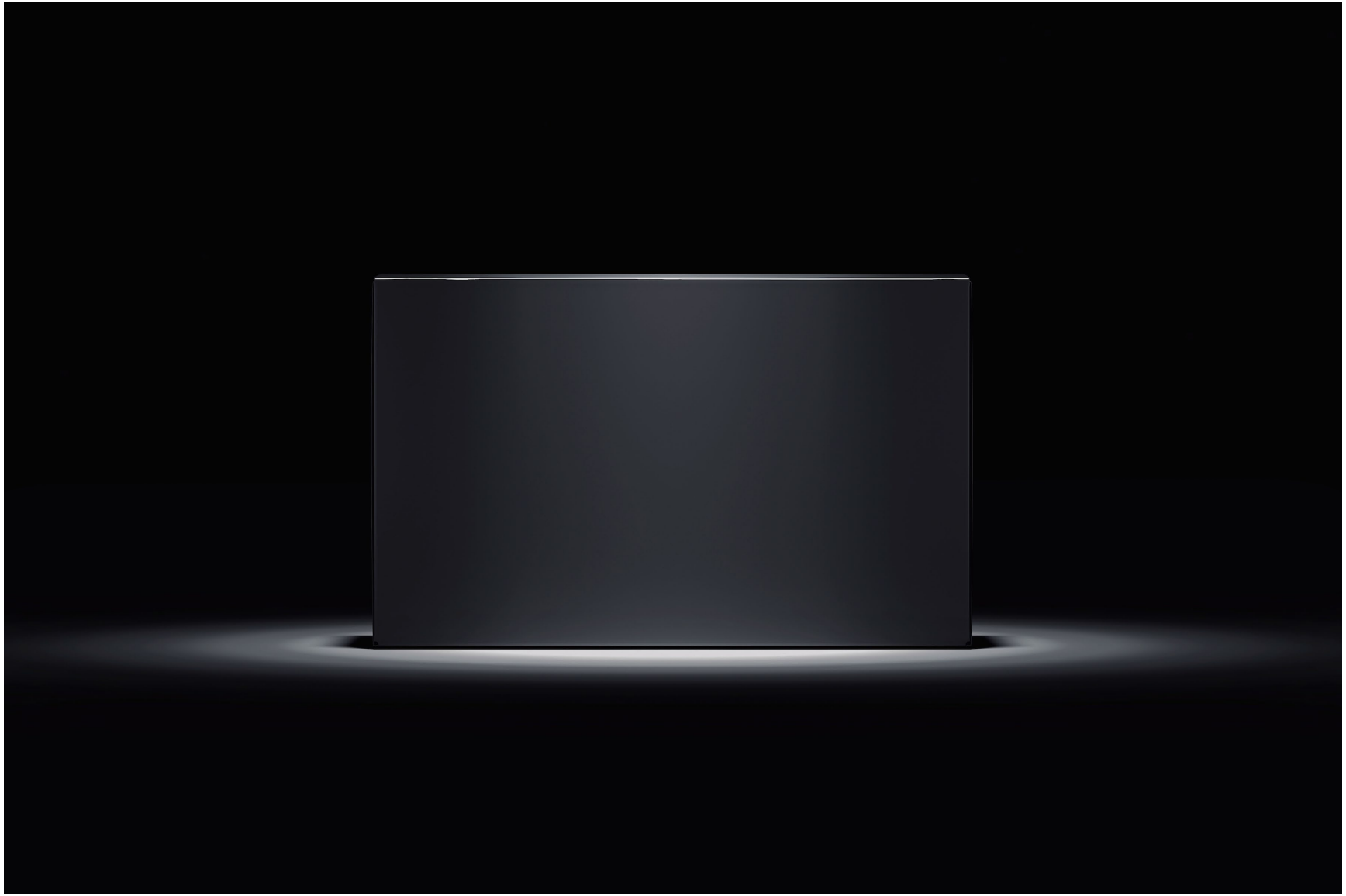
“….The application of chicken genetics via artificial selection by humans, however, began with the domestication of the chicken in Neolithic times.” *Siegel et al., 2006*


Potential
Actual
Animal protein
Feed & other inputs

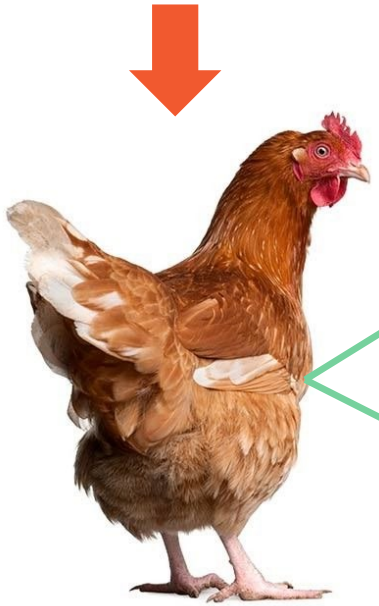

ECONOMY
SOCIETY
ENVIRON-
MENT

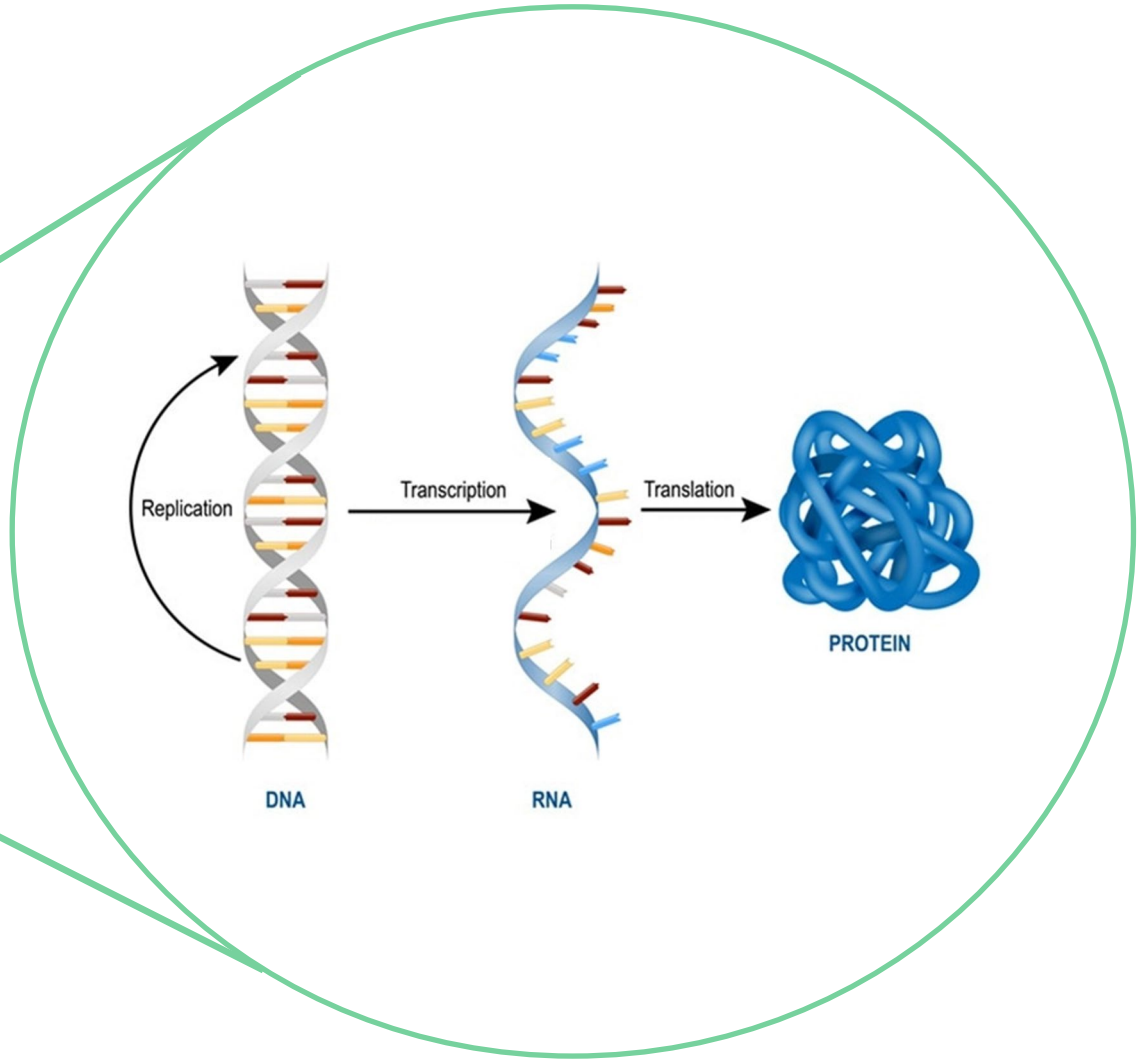


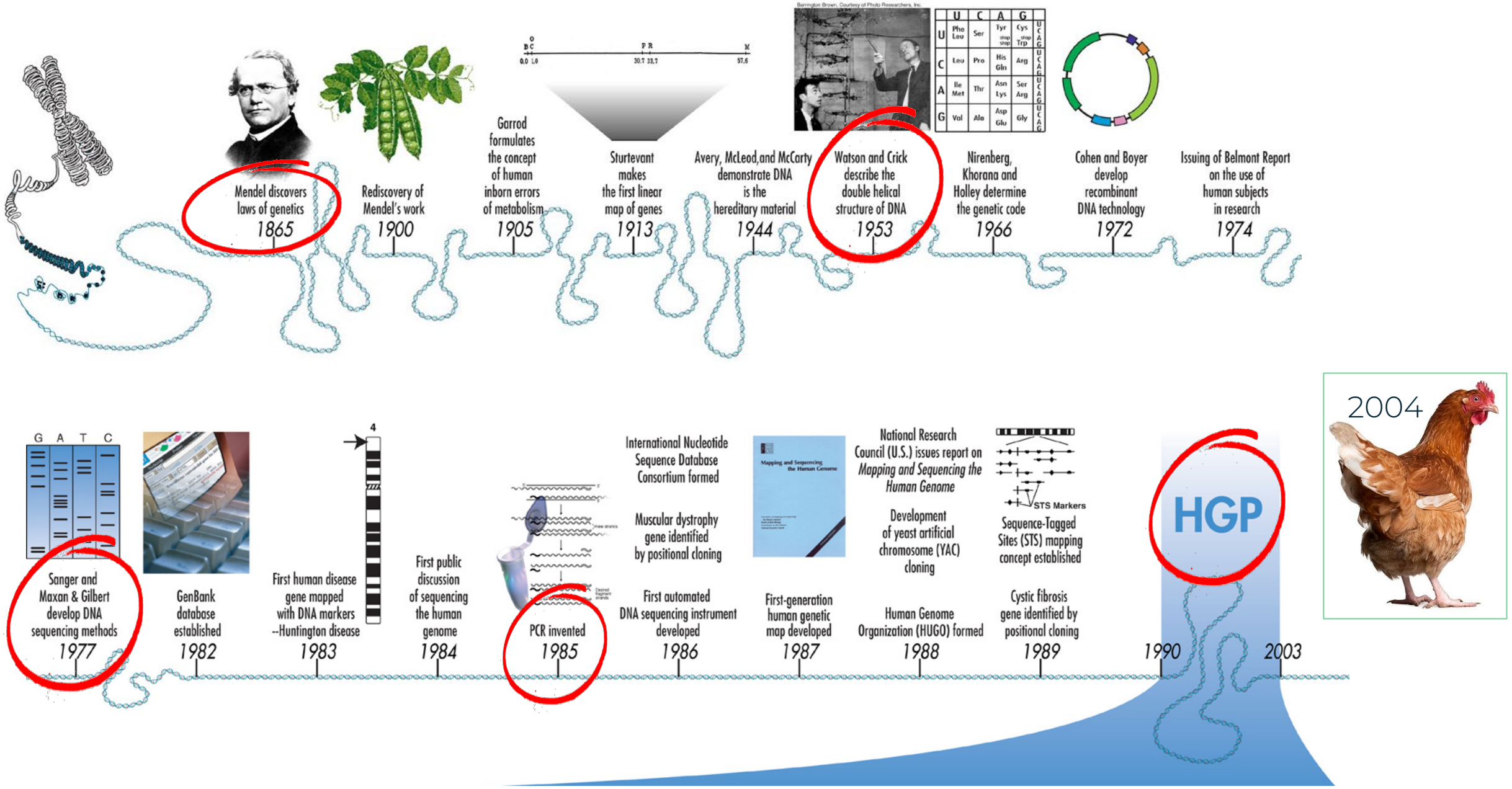
PHENOTYPE
Performance + Sustainability



Environment





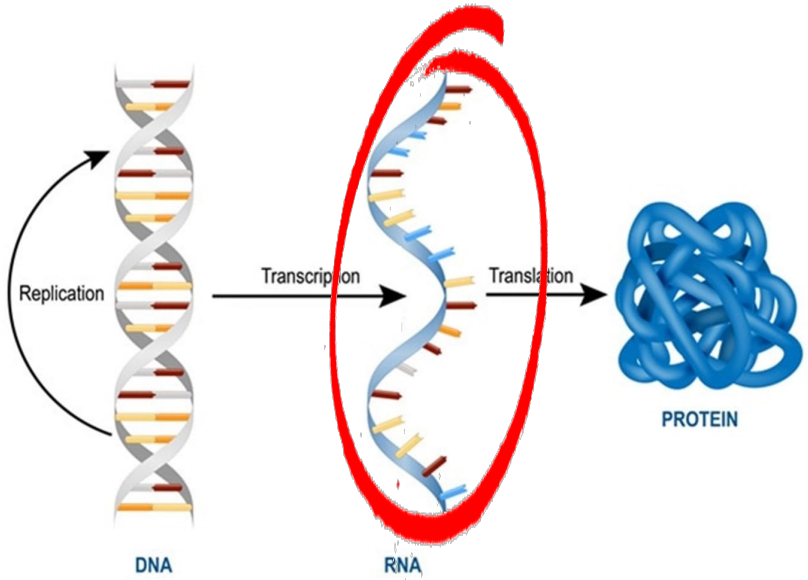


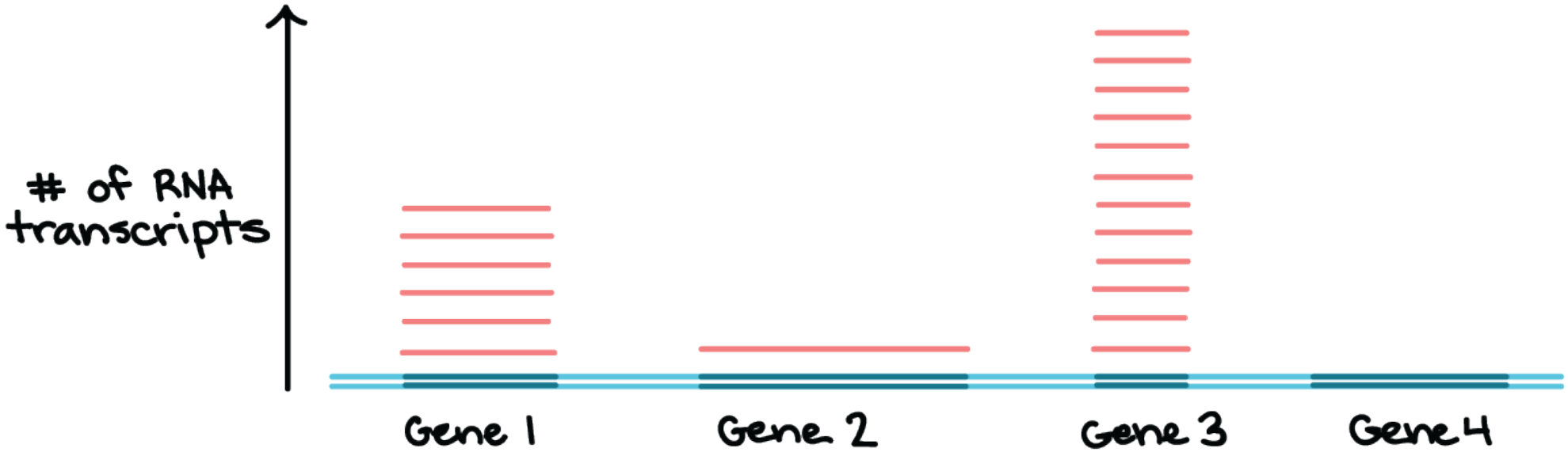
https://upload.wikimedia.org/wikipedia/commons/3/33/Human_Genome_Project_Timeline_%2826964377742%29.jpg

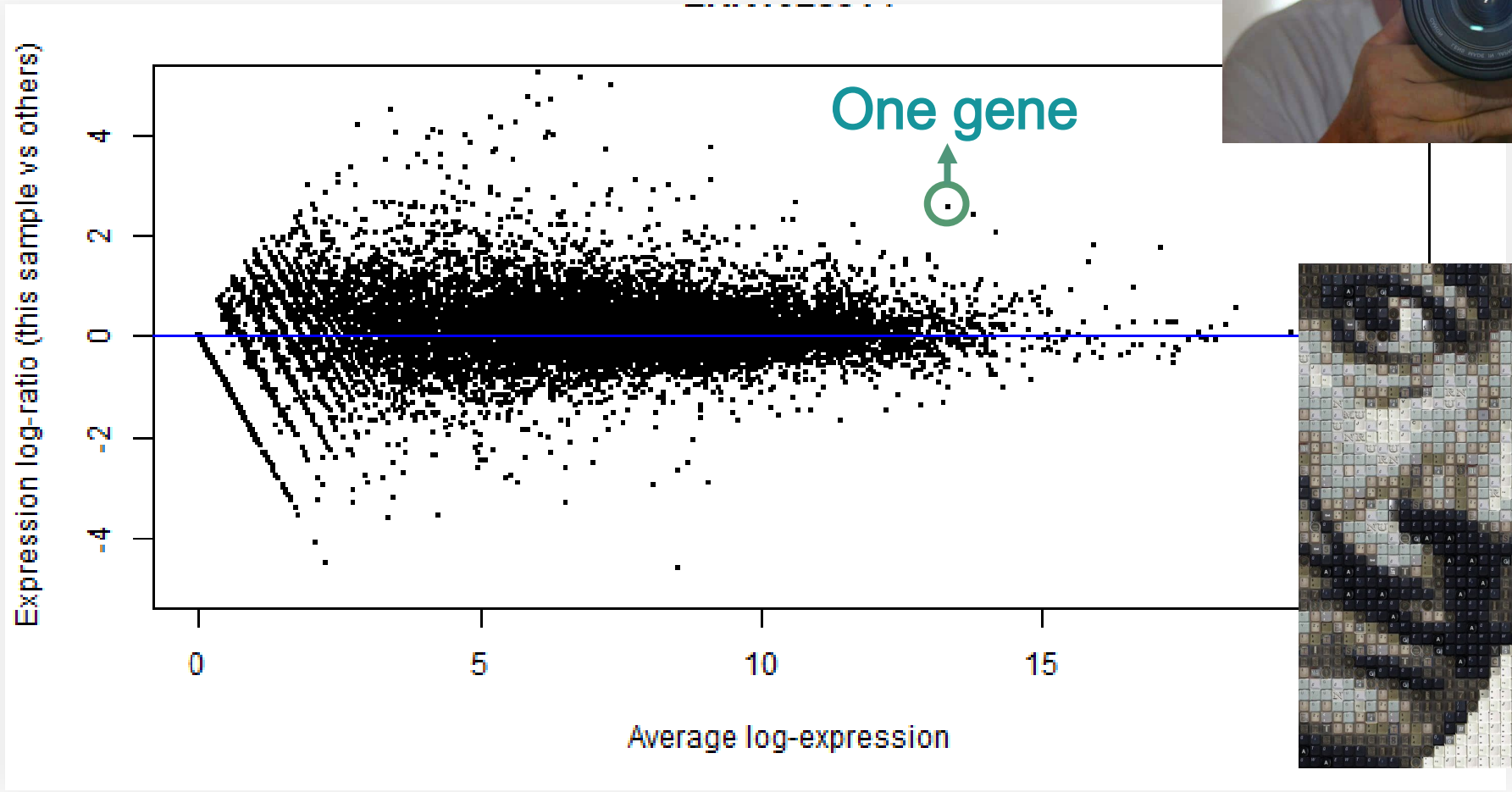
The chicken reference genome

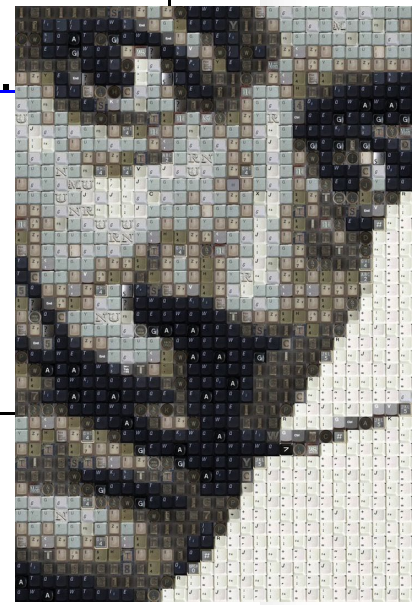
Latest version released in 2022

- Coding Genes 17,007
- Non-coding genes 13,040

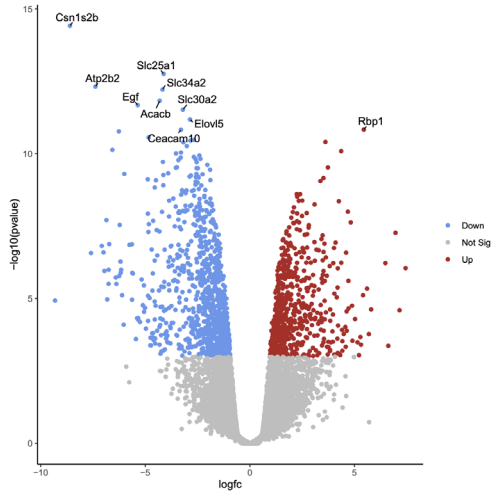

Replication
Transcription
Translation
PROTEIN
DNA
RNA

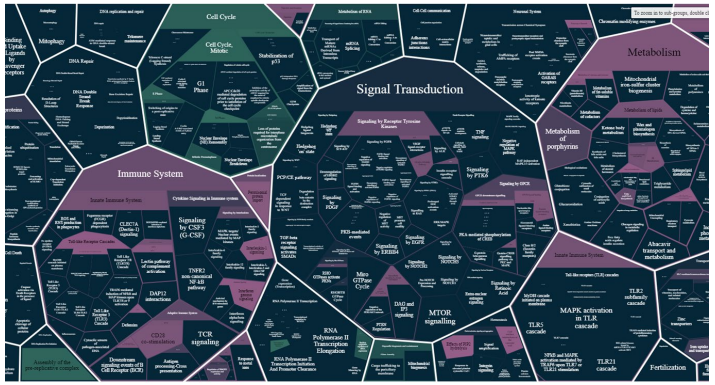

# of RNA transcripts
Gene 1
Gene 2
Gene 3
Gene 4


Expression log-ratio (this sample vs others)
4
2
0
-2
-4
0
5
10
15
Average log-expression
One gene



Genes | Pathways & functions | Value-insights





"A limitation of branched-chain amino acids is costing you 3 points of FCR..."
*

An example

A field study with broiler flocks

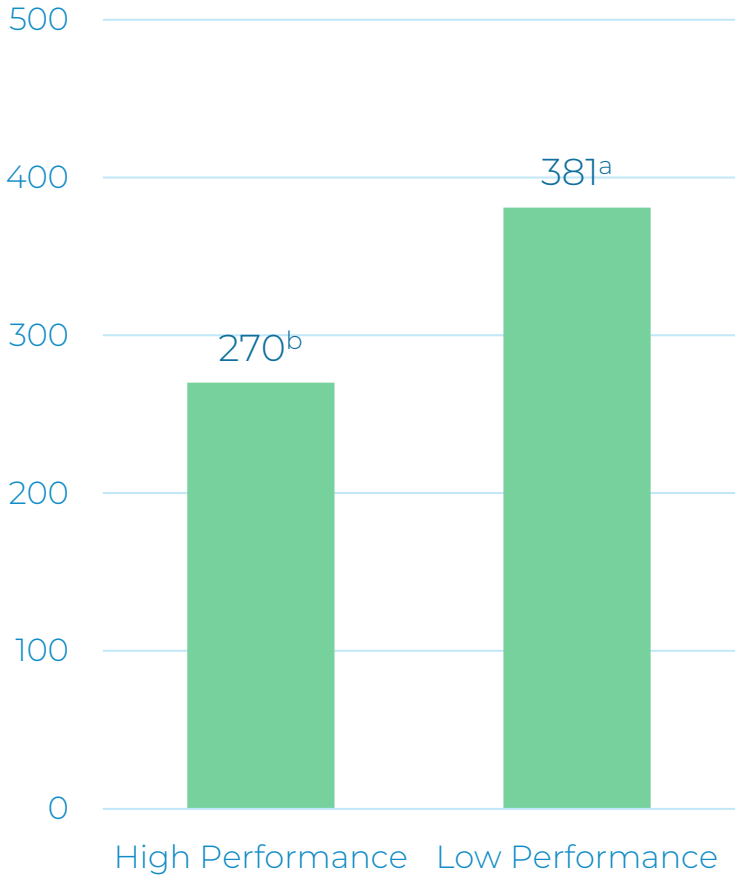
- Four farms from the same complex and age
- Mixed-sex Ross-708 broilers, NAE program
- Sixteen healthy birds per farm sampled at 28 d:
  - Liver for mRNA sequencing
  - Jejunum for histology
- RNA extracted
- mRNA was sequenced using the Illumina platform

Performance at end of cycle (63 d)

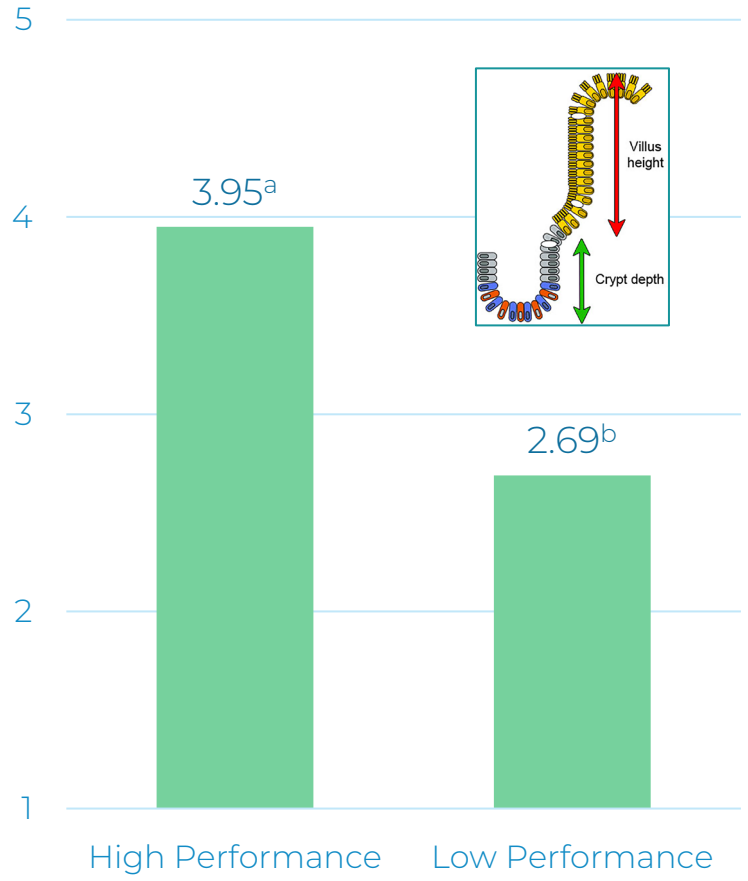
Farm	Housed birds (#)	Slaughter age (d)	Adjusted FCR (g/g)	Final average BW (g/bird)	Mortality (%)	Performance category
Farm 1	113,100	63	1.933	4,187	6.54	Low Performing
House A	37,700	63	1.925	4,191	6.13	
House B	37,700	63	1.958	4,155	7.34	
House C	37,700	63	1.915	4,214	6.14	
Farm 2	81,700	63	1.868	4,246	4.32	High Performing
Farm 3	154,400	63	1.867	4,309	4.60	High Performing
Farm 4	78,000	63	1.923	4,096	5.38	Low Performing

Histological differences in jejunum

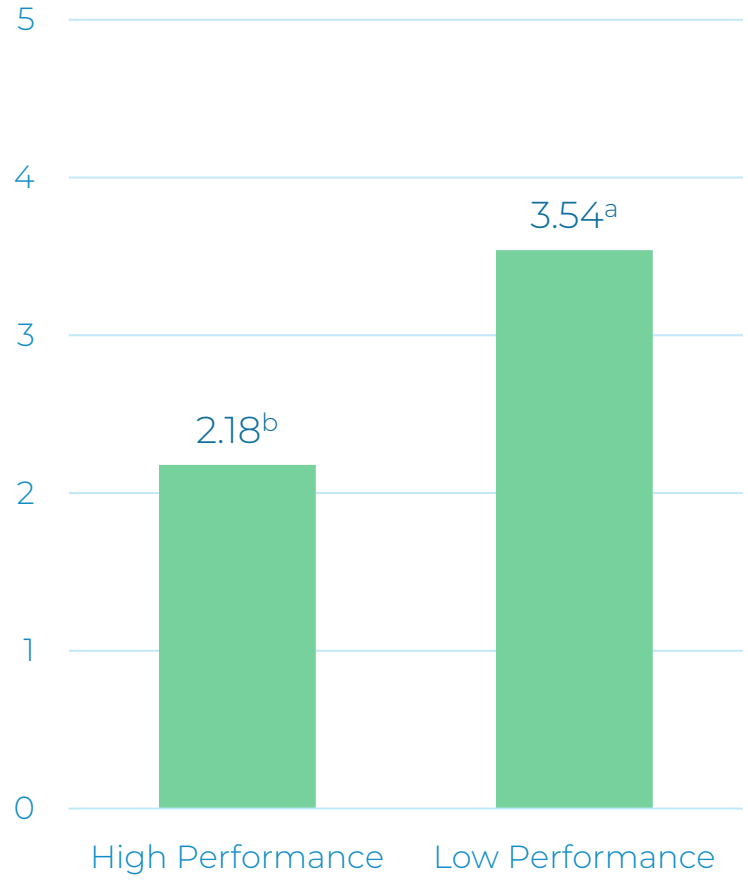
Crypt depth (µm)



Villi length : Crypt depth



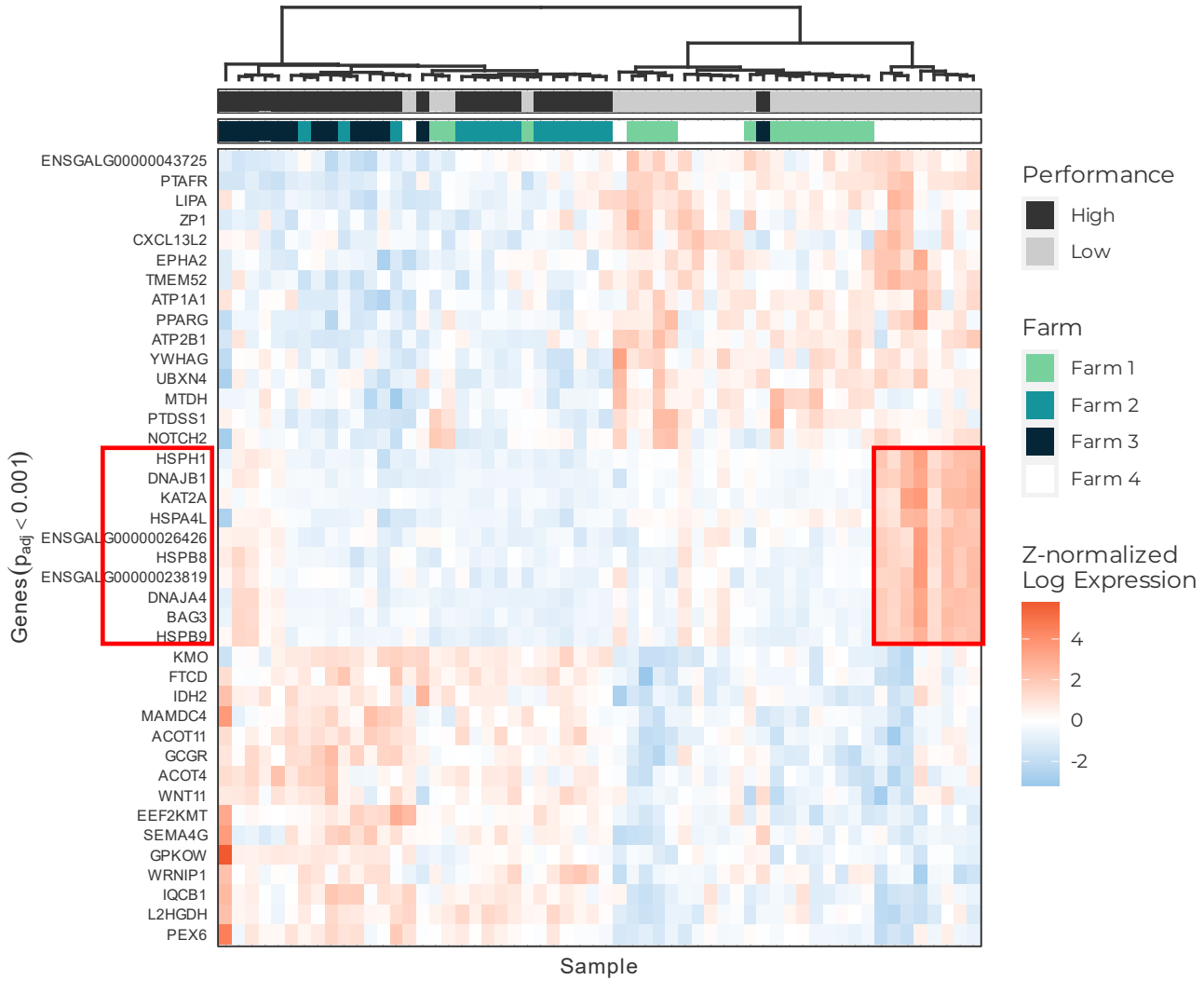
Crypt heterophils (0-5)



Differential gene expression of Low versus High performing farms

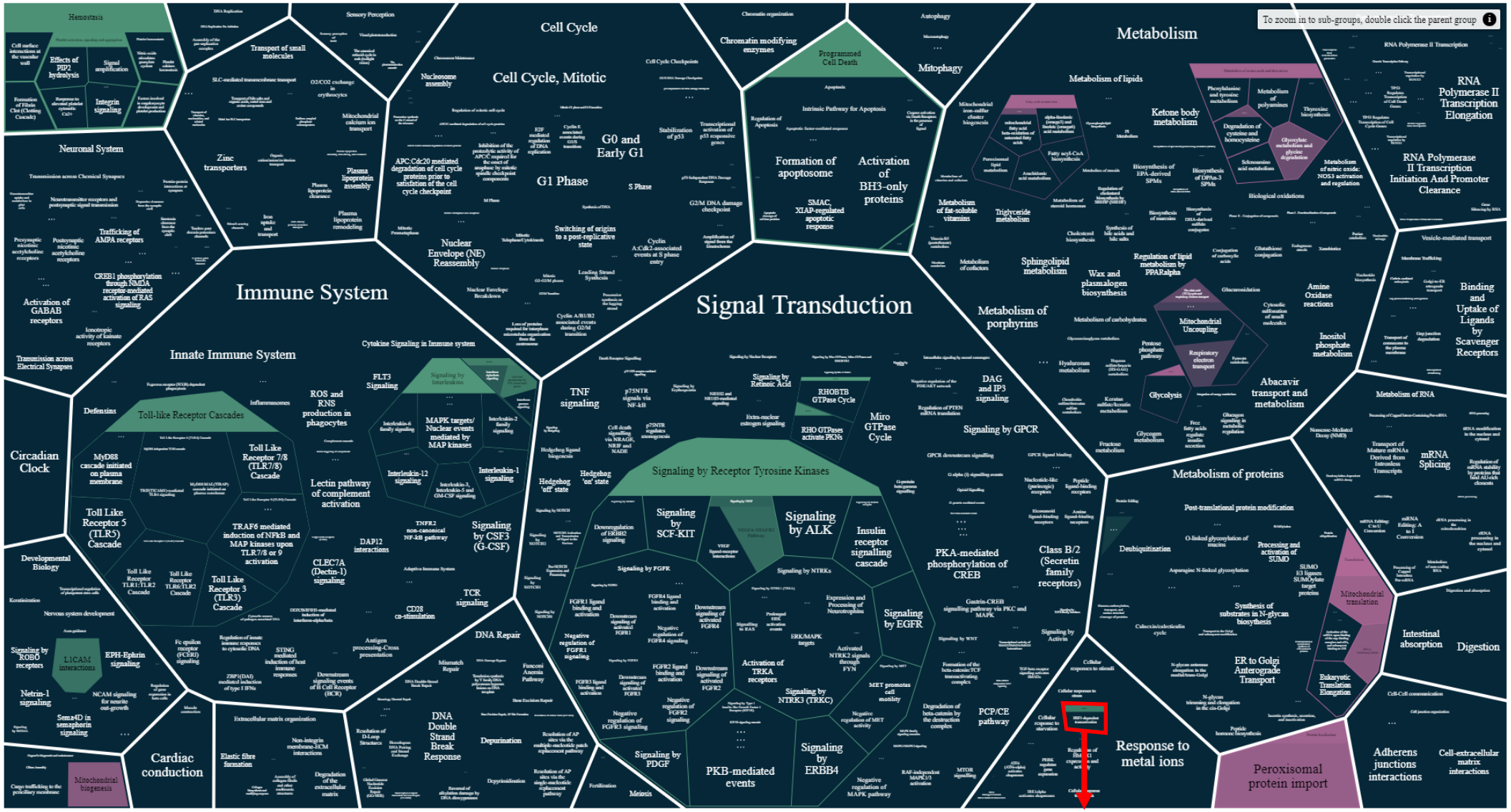
Analysis	Differentially expressed genes[1] adj P < 0.05
Low Performing vs. High Performing	1,307

[1] From a total of 14,828 genes analysed



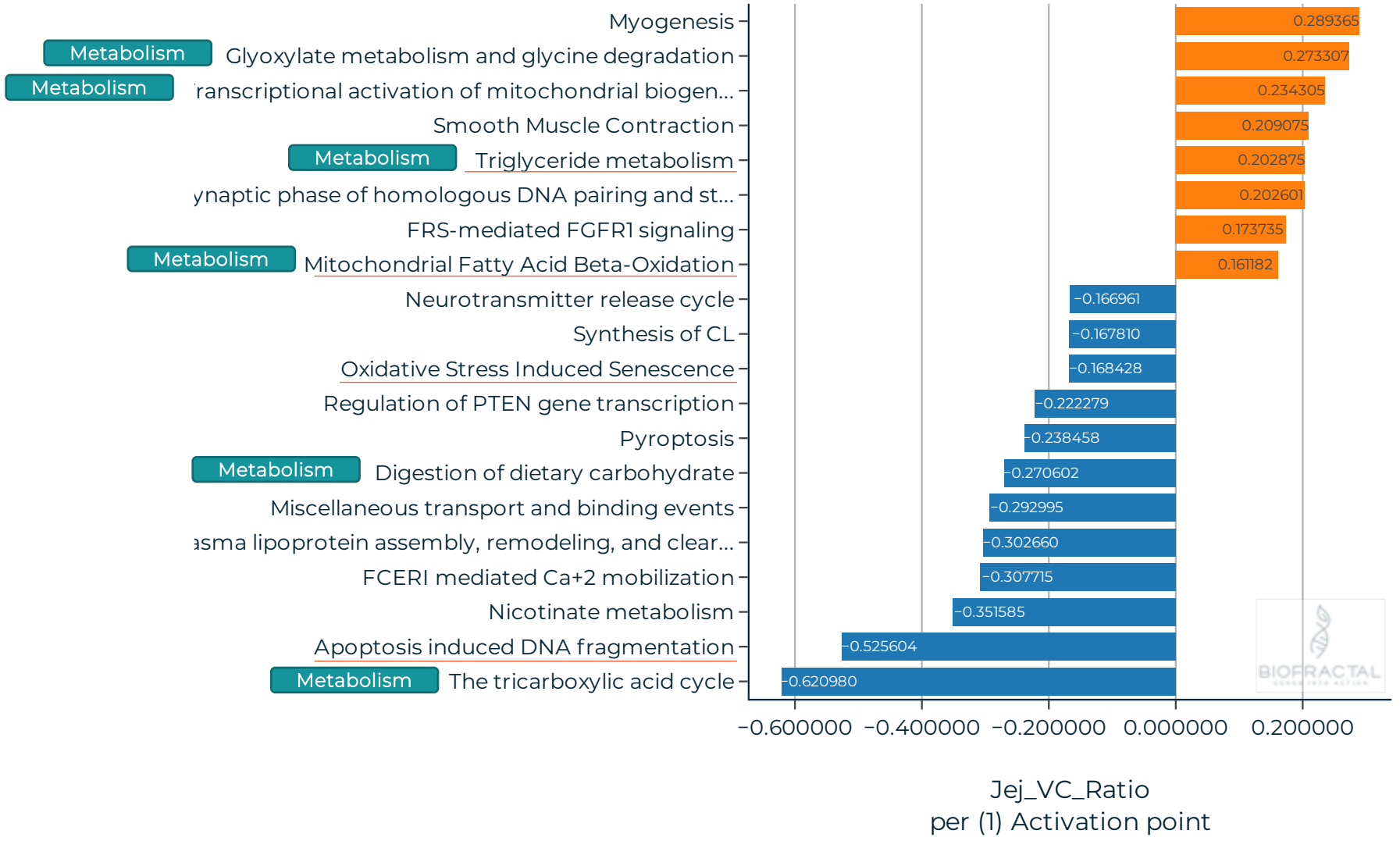
Purple = downregulated; green = upregulated

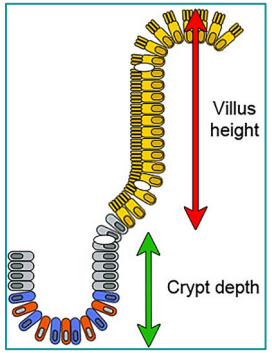
Pathway enrichment in liver. Low Performance versus High Performing Farms



Purple = downregulated; green = upregulated

Liver pathways with the highest association with villi length to crypt ratios in jejunum

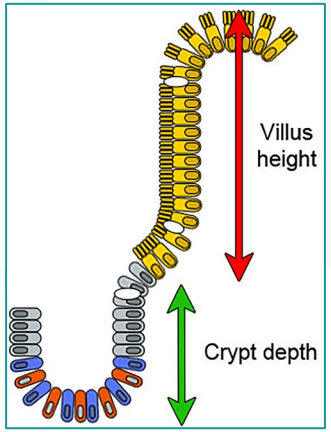




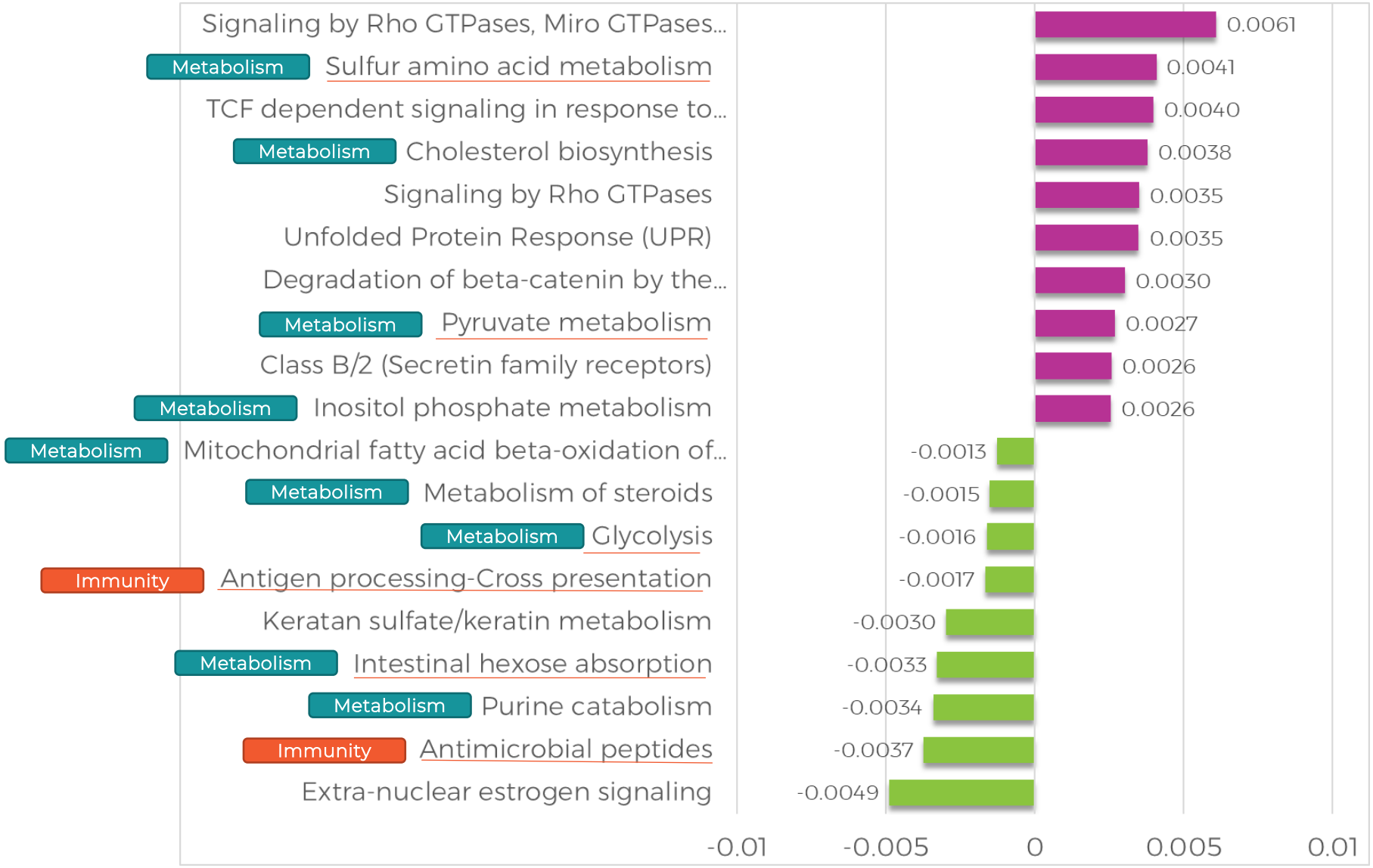
99 features

R^2 = 0.99

Increased villi length to crypt depth ratios in jejunum were associated with activated fat metabolism in liver

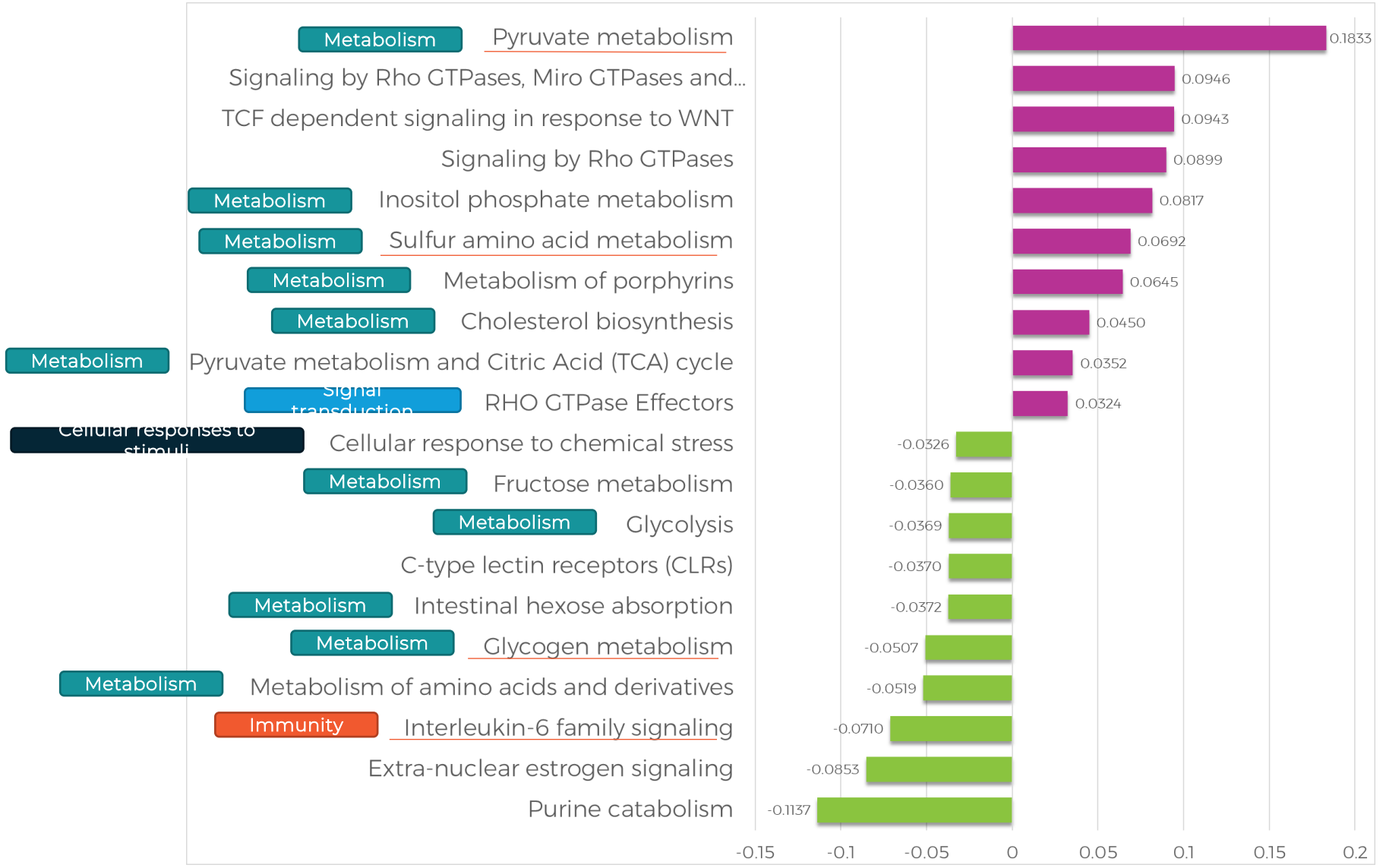


Liver pathways with the highest association with final flock FCR



34 features
R^2 = 0.75

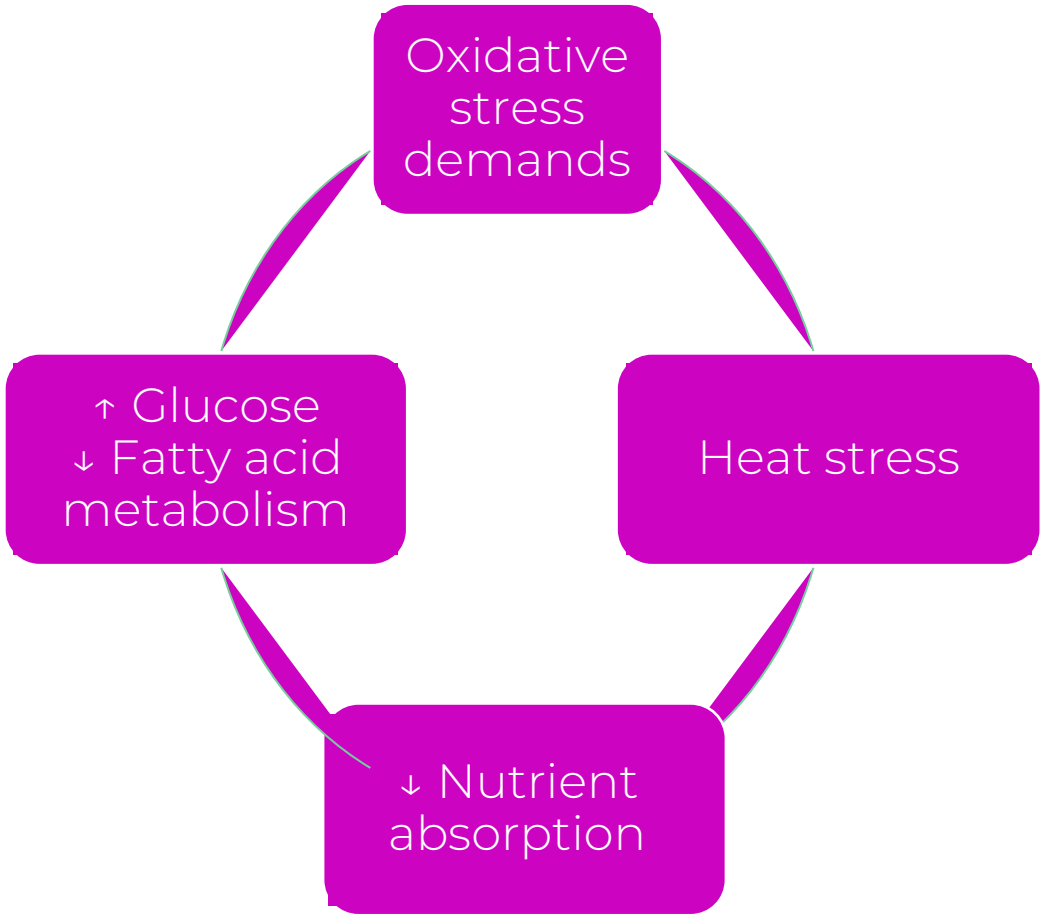
Liver pathways with the highest association with final flock mortality

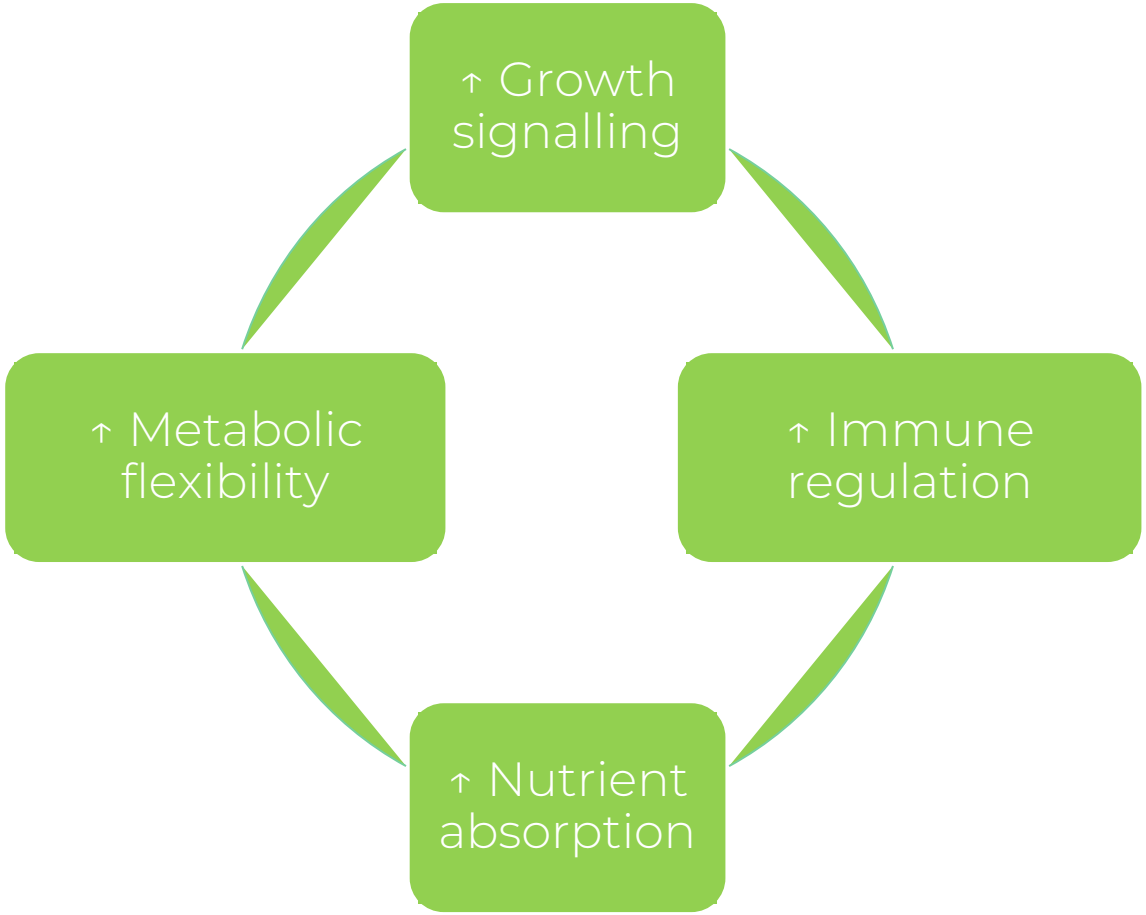


44 features

$R^2 = 0.70$

Low Performance versus High Performance Flocks





Gene expression can provide valuable insights of problems and solutions in poultry production

Gut health

Disease

Nutritional deficiencies

Toxicities

Stress

Feed additives

What does the future hold?

- Cheaper, faster, better applications
- Integration of data
- Actionable data as a competitive advantage

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Customer-driven innovation in animal nutrition and health

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