Selection for natural antibodies affects mortality after avian pathogenic *Escherichia coli* (APEC) infection in chickens

WIAS Science Day 2017

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Co-authors/Collaborations

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- Mariska Mesman

Utrecht University

- Mieke Matthijs
- Marius Dwars

Organisations

- STW
- ISA - Hendrix Genetics

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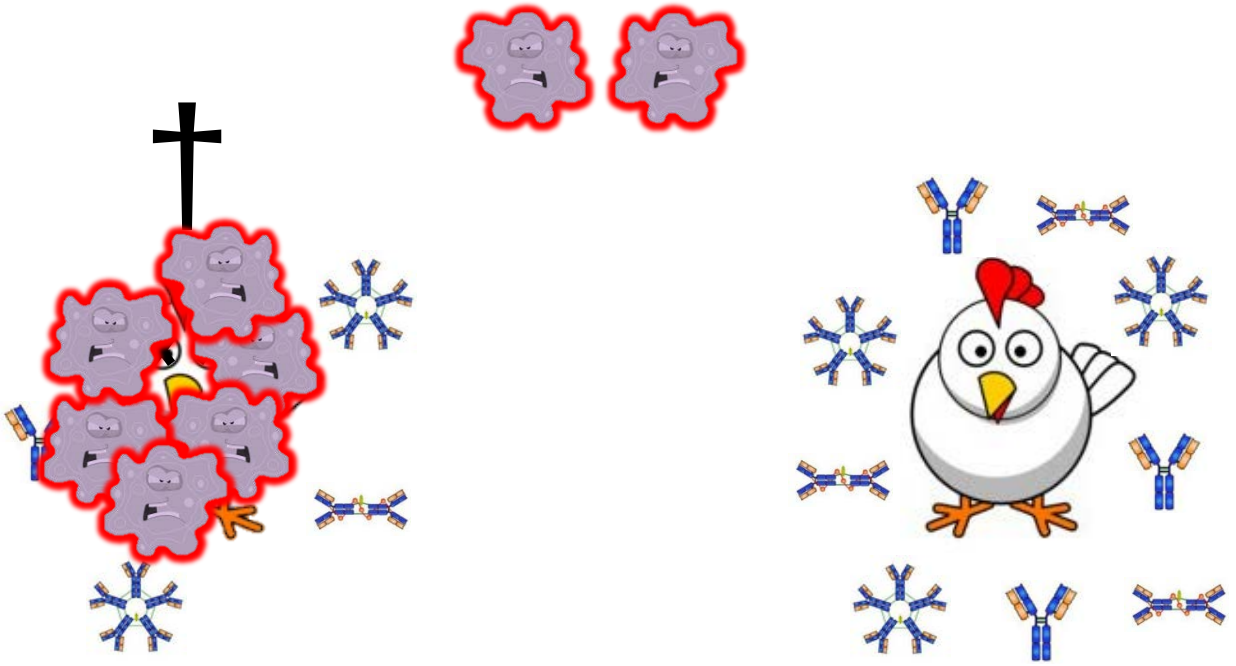
ISA
A Hendrix Genetics Company

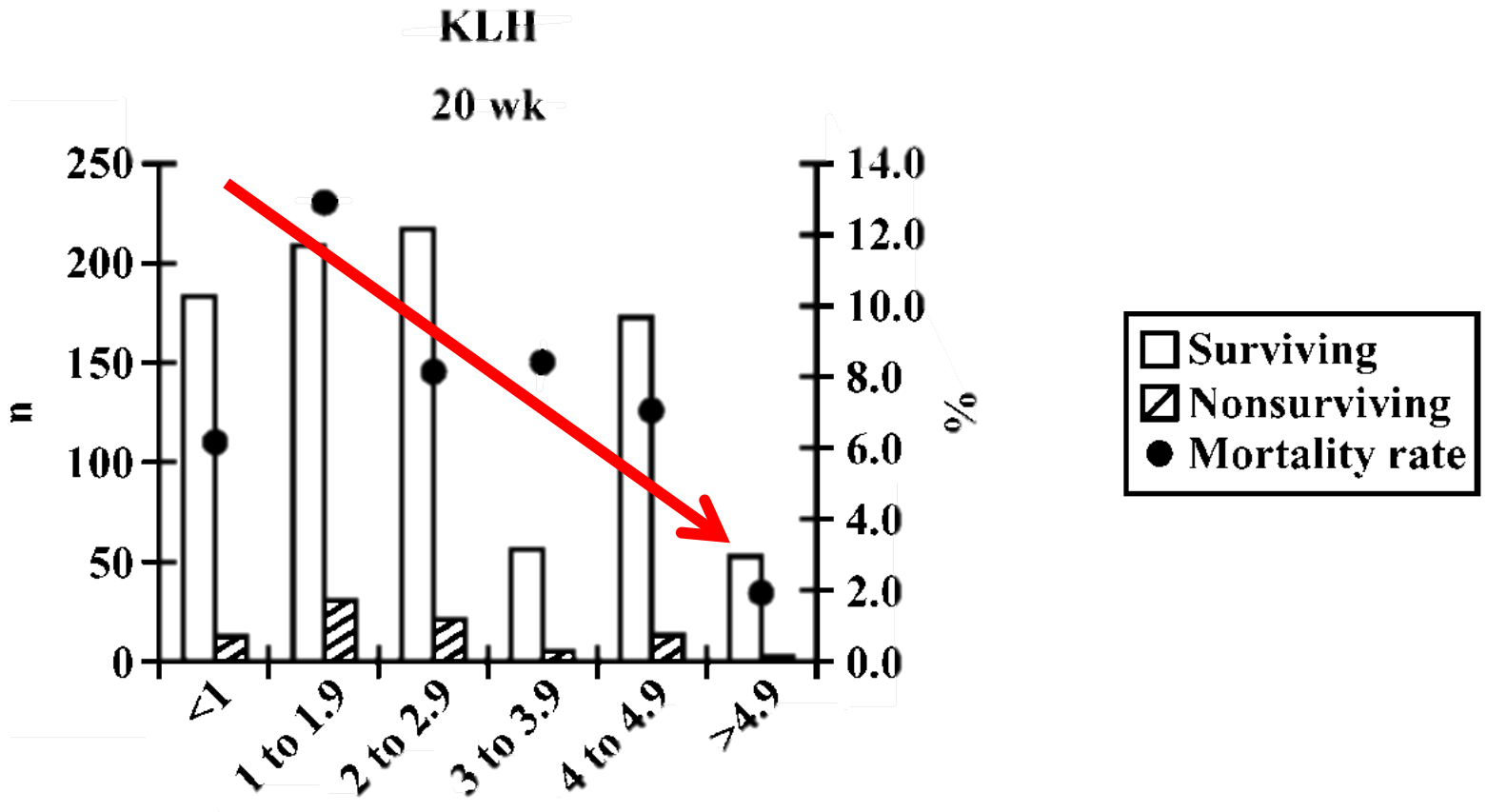
STW
Enabling new technology

Natural antibodies?



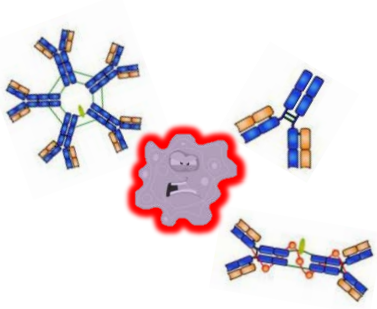
Natural antibodies!

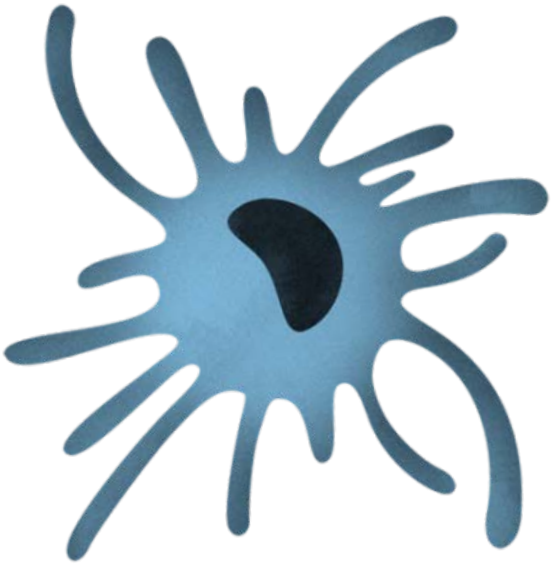
Star *et al.*, 2007, Poultry Science

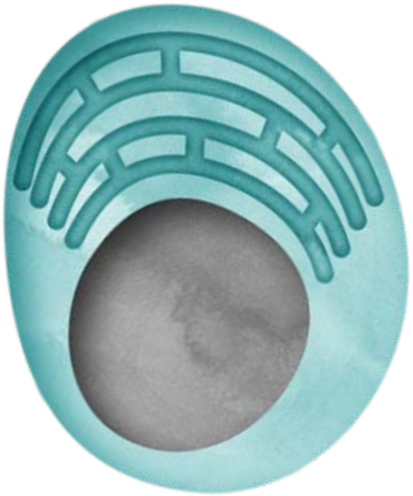


Natural antibodies

- Neutralization of pathogen
- Activation of complement system
- Formation of complexes/Opsonisation
- Antibody response







Natural antibodies

Antigen binding antibodies present in individuals without exposure to this antigen

Natural antibodies binding KLH

Antigen binding antibodies present in individuals without exposure to this antigen

Keyhole Limpet Hemocyanin (KLH)

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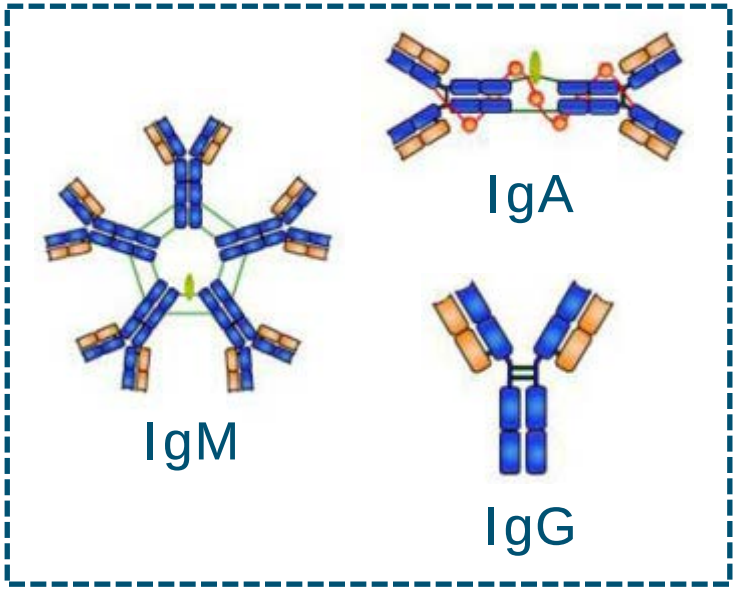
Natural antibodies binding KLH

Antigen binding antibodies present in individuals without exposure to this antigen

Keyhole Limpet Hemocyanin (KLH)

- Plasma titers
  - IgTotal → Total levels
  - IgM (IgTotal)
  - IgA
  - IgG

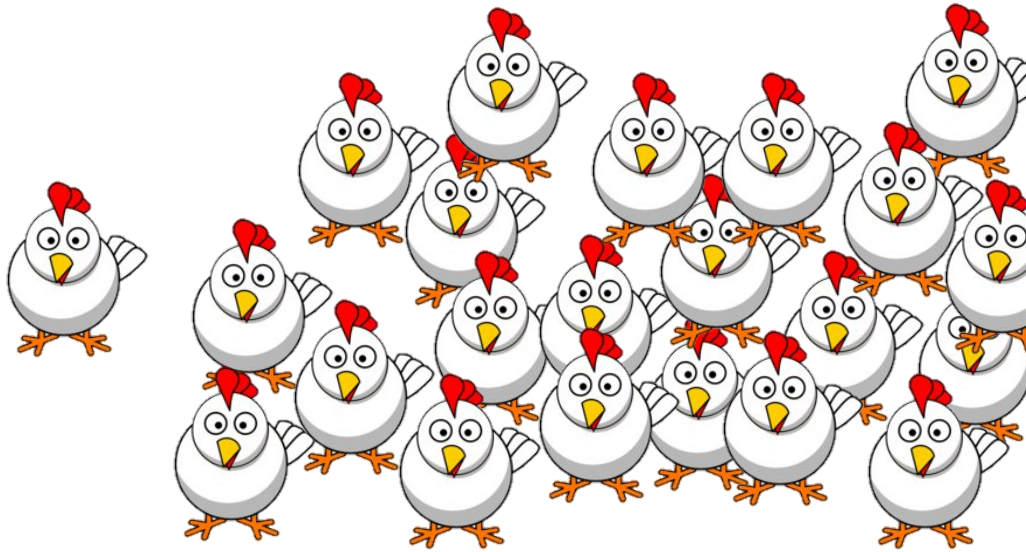


Objective

To improve general disease resistance of chicken by selective breeding for natural antibodies

Selection criterion

IgTotal natural antibodies binding KLH at 16 weeks of age



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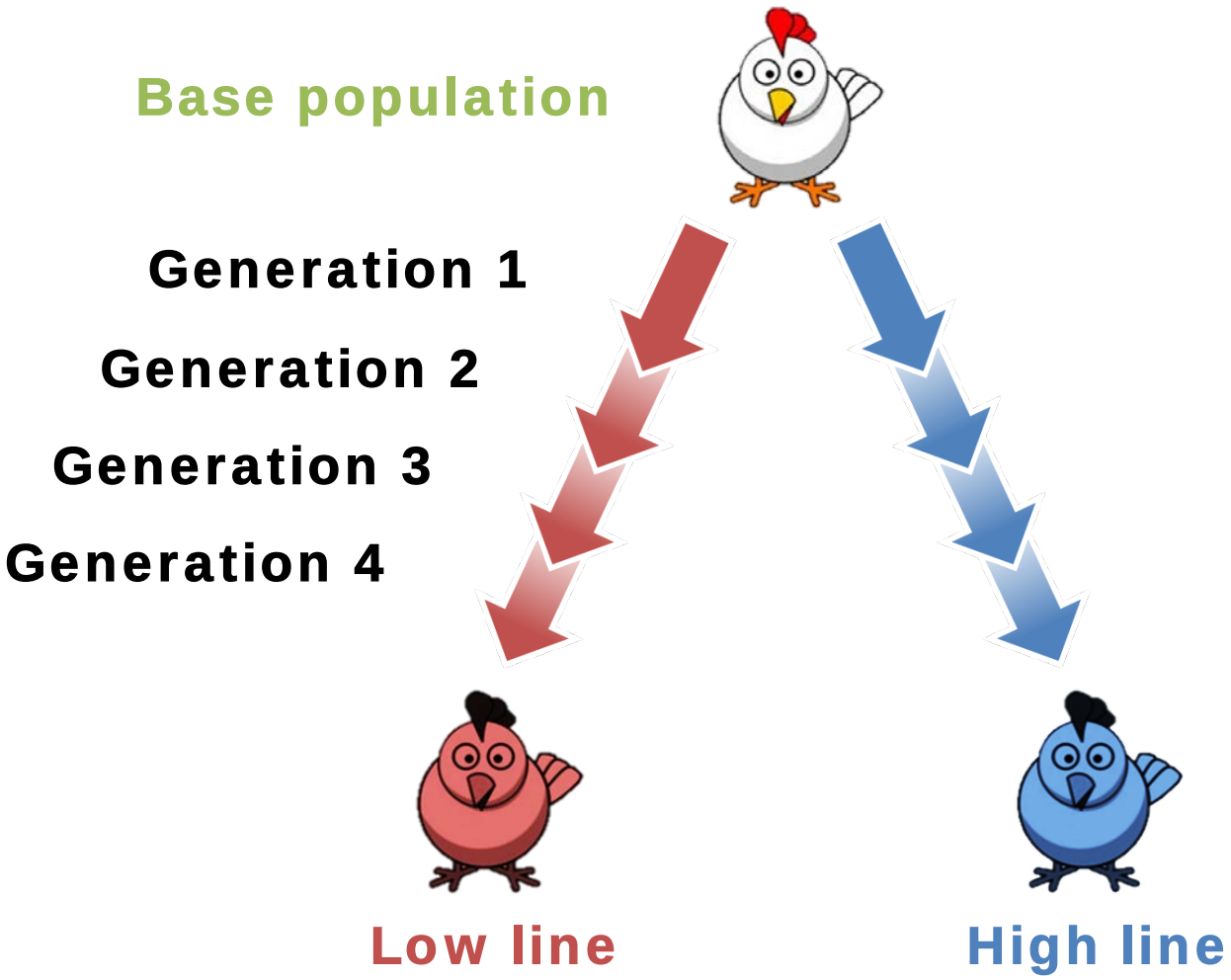
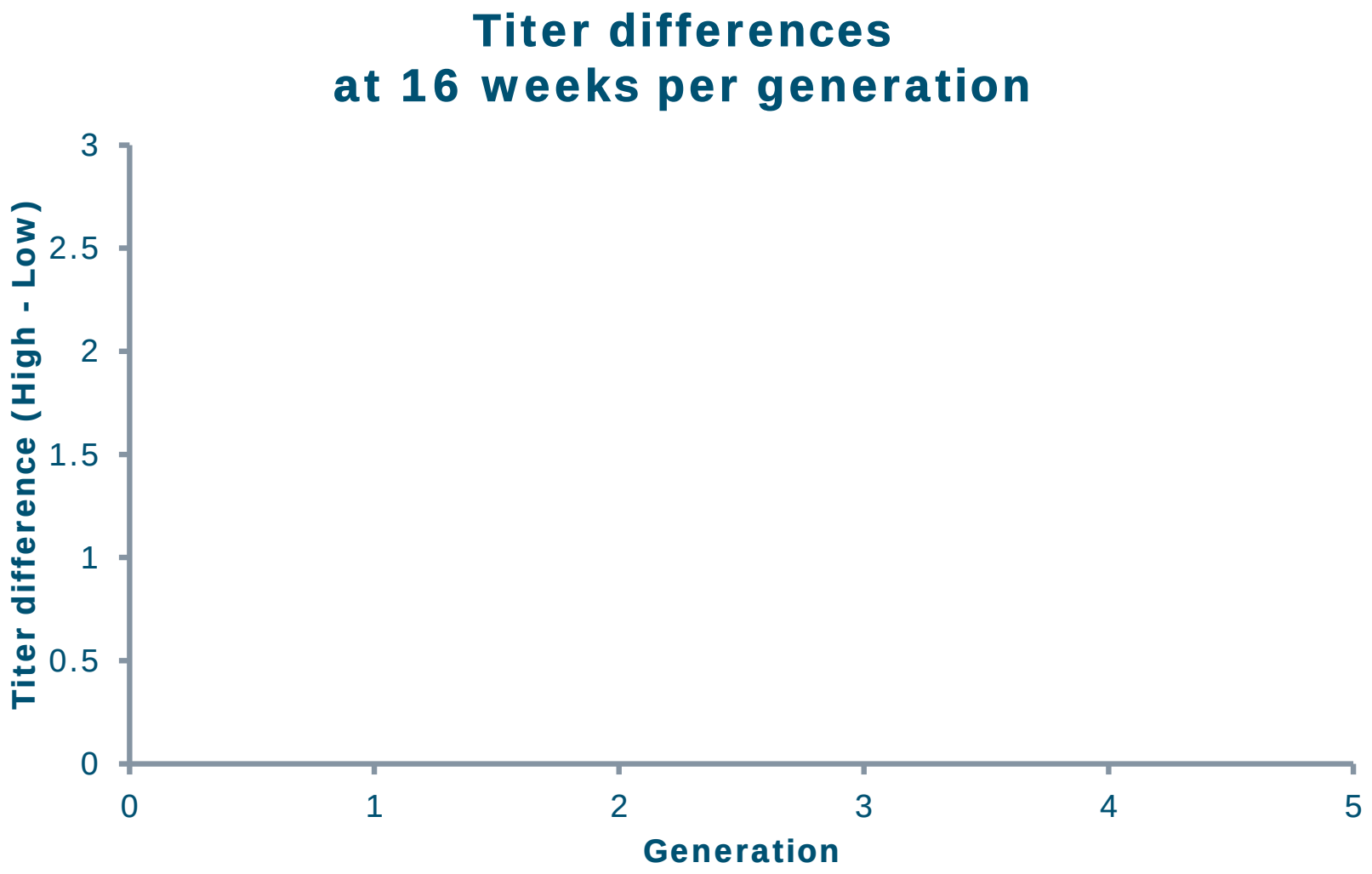
Selection progress



Selection response



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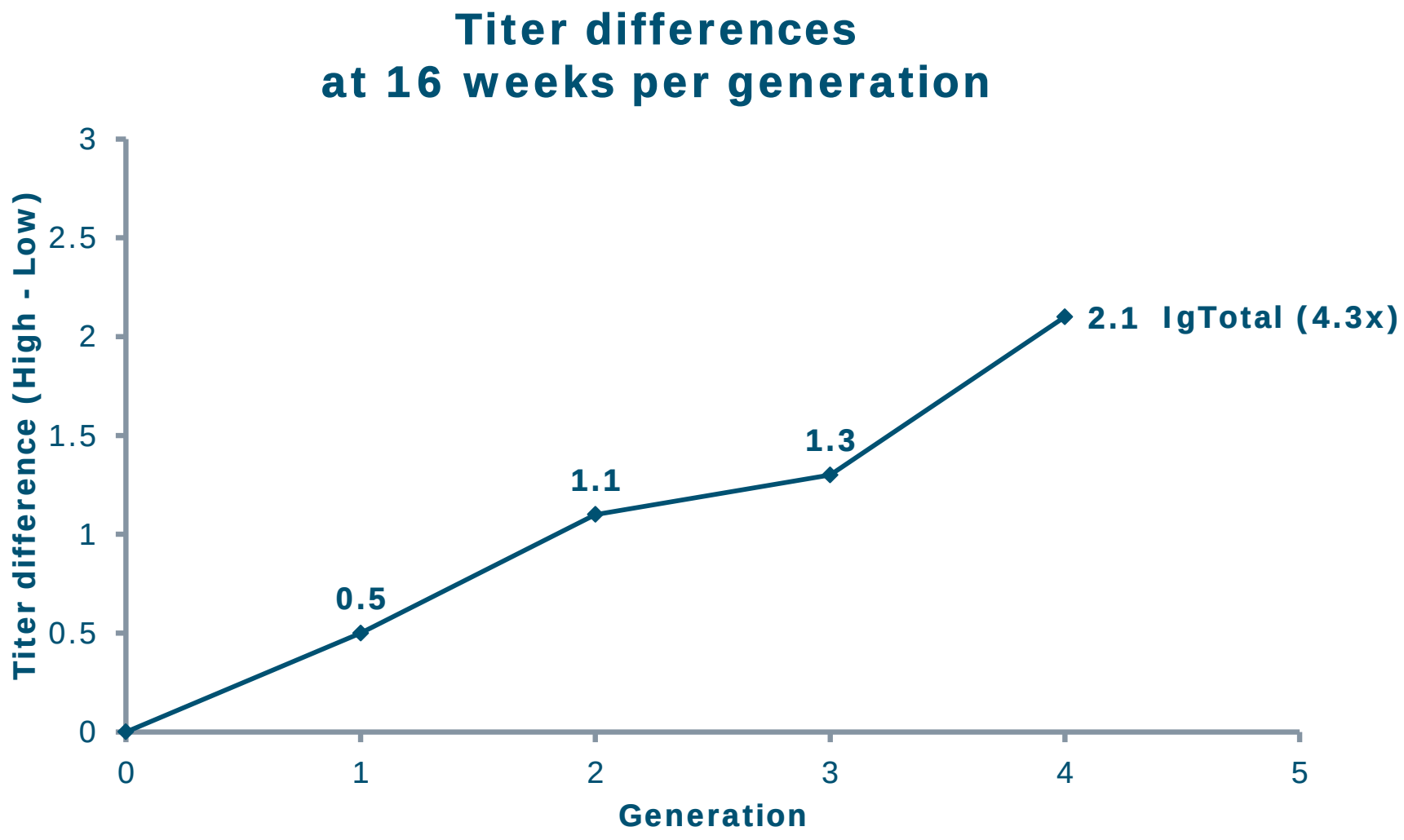
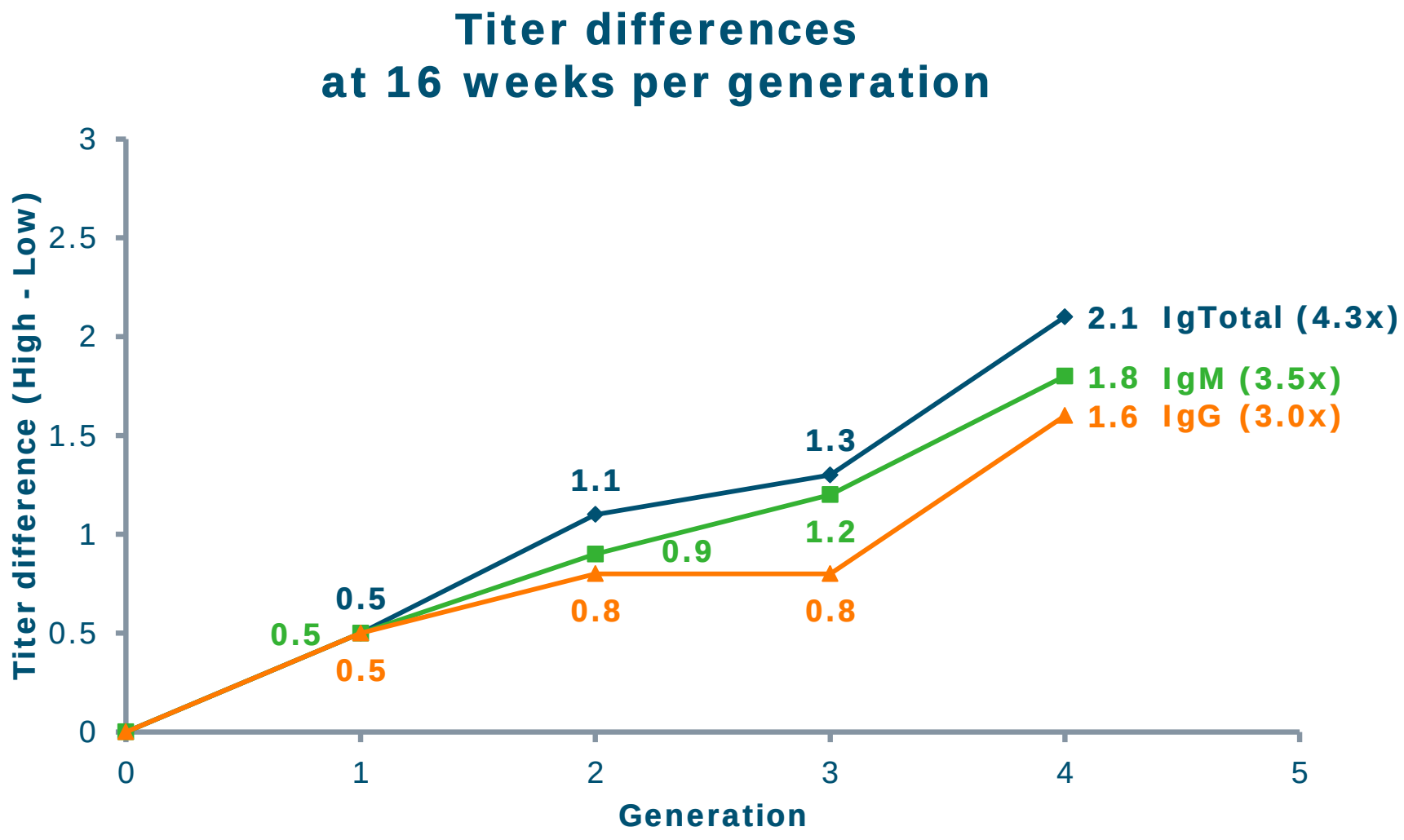
Selection response



Selection response



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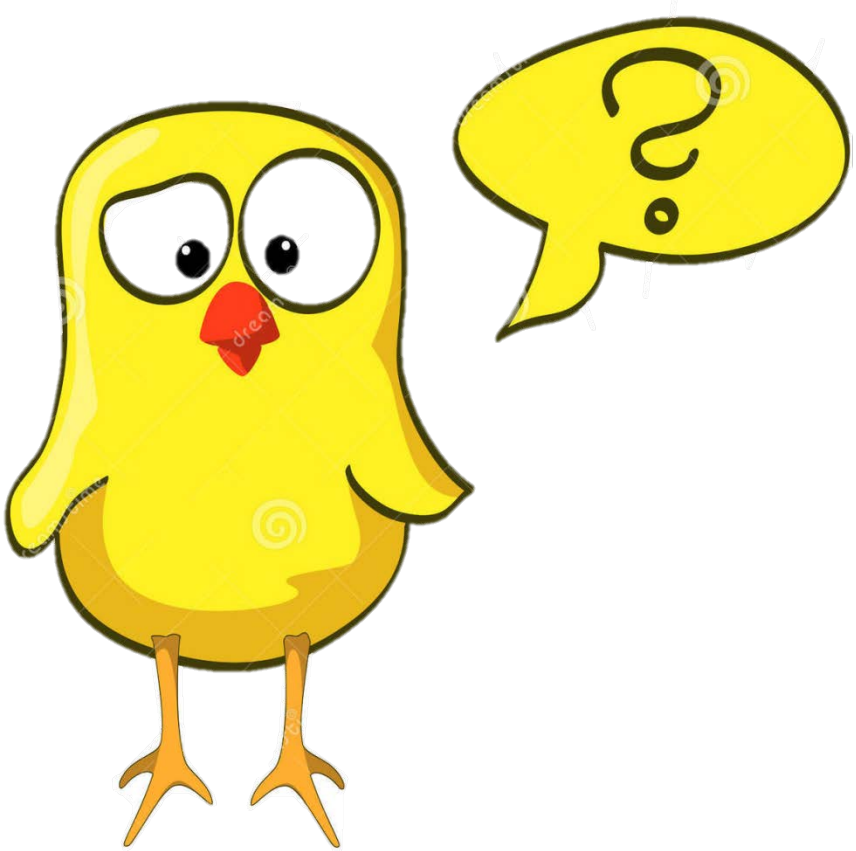
Breeding for (general) disease resistance?



Breeding for (general) disease resistance?

Proof-of-principle

- Avian pathogenic *E. coli* (APEC)
  - *Escherichia coli* serotype O78:K80 (strain 506)
- Intratracheal inoculation at young age
  - $10^{7.5}$ CFU









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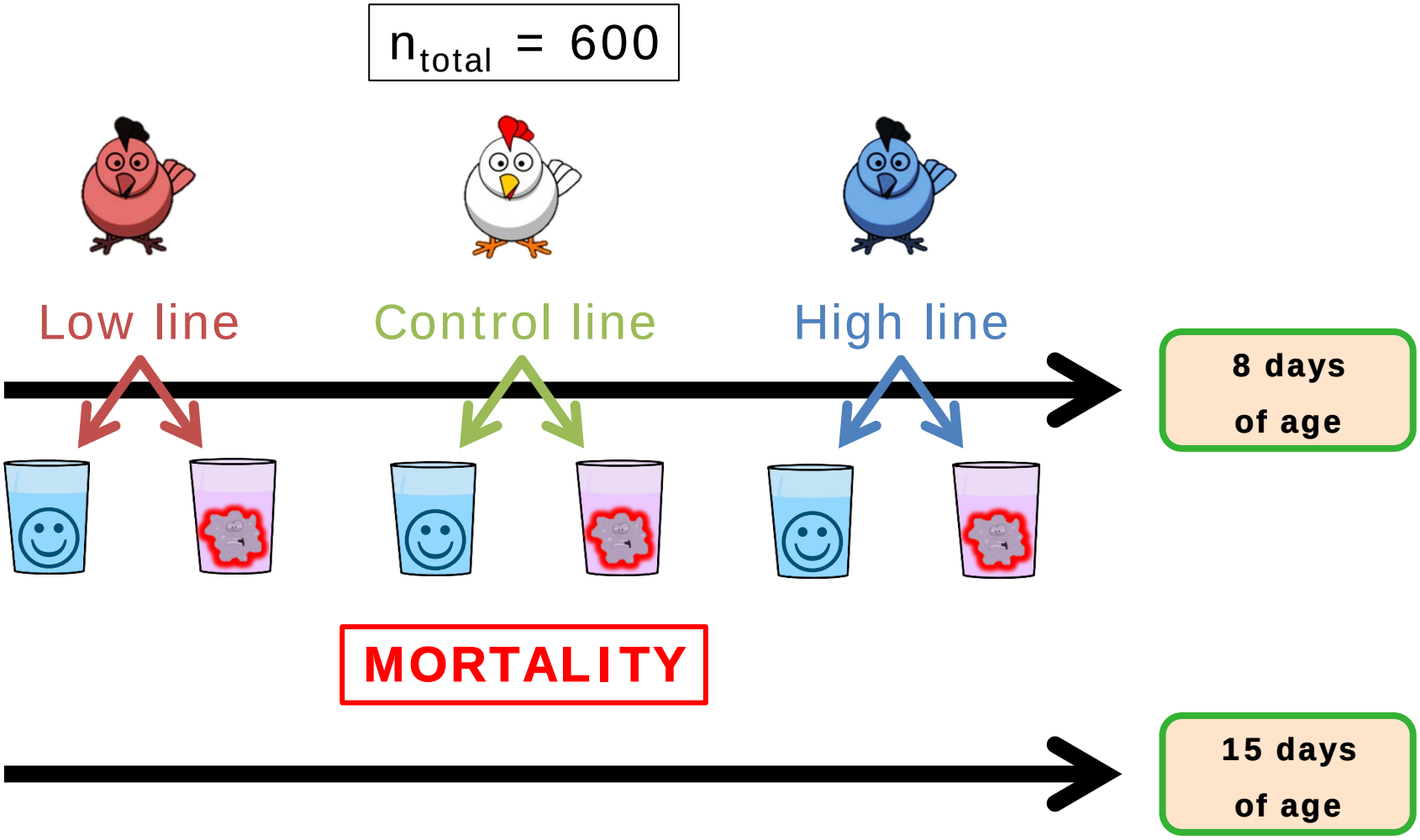
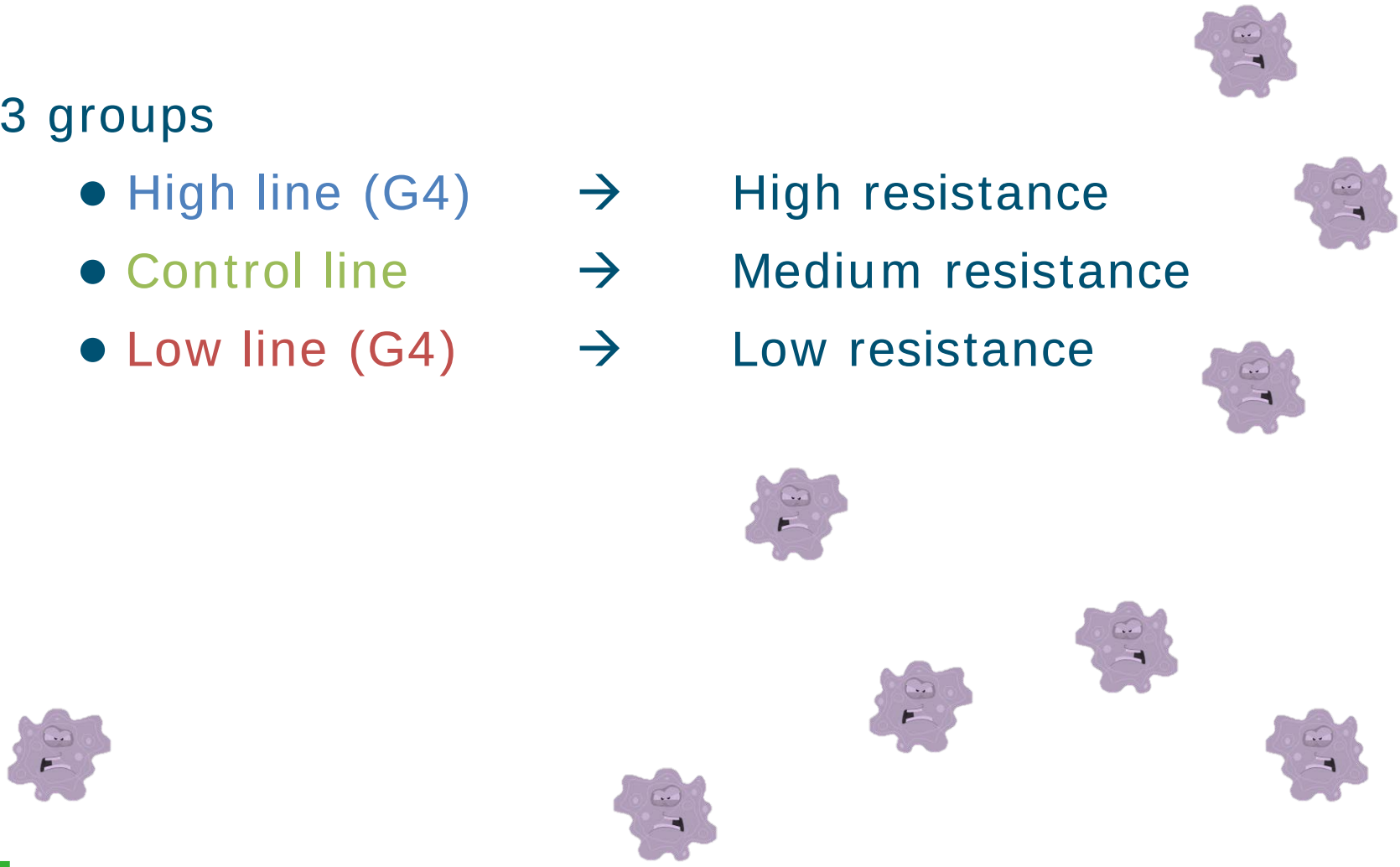
Set-up

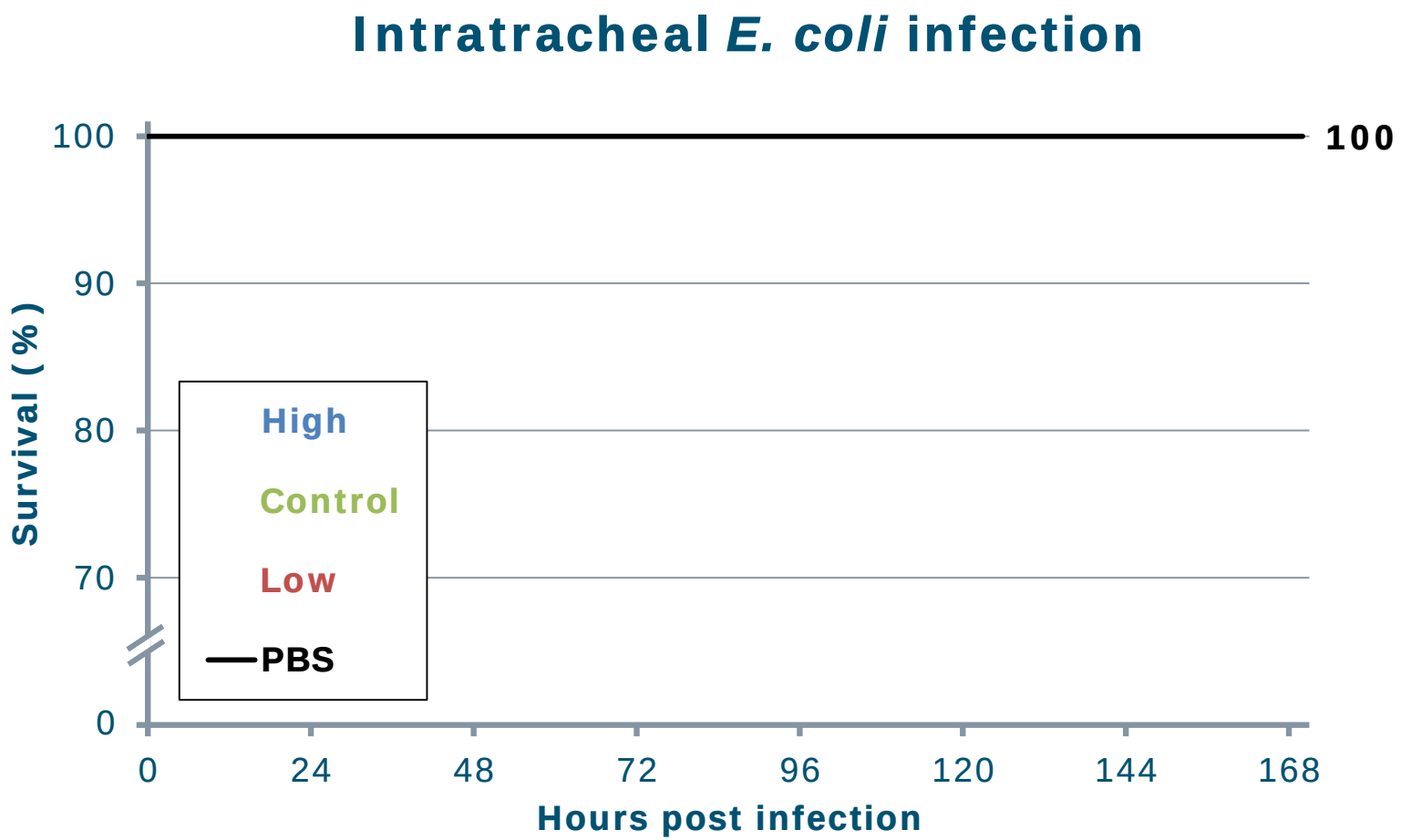

n_{total} = 600
Low line
Control line
High line
8 days of age
MORTALITY
15 days of age

Hypotheses

- 3 groups
  - High line (G4) → High resistance
  - Control line → Medium resistance
  - Low line (G4) → Low resistance



Results



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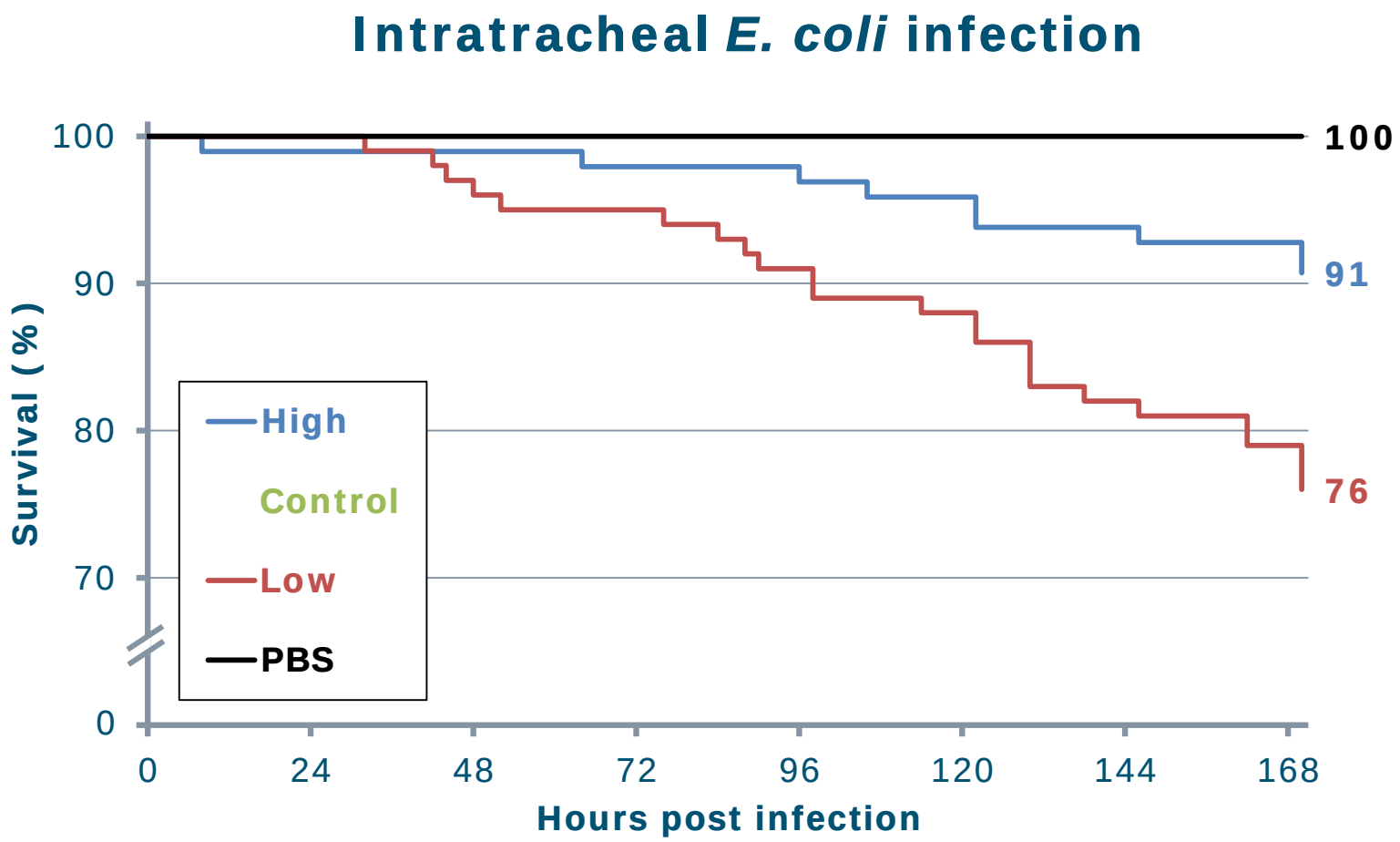
Results



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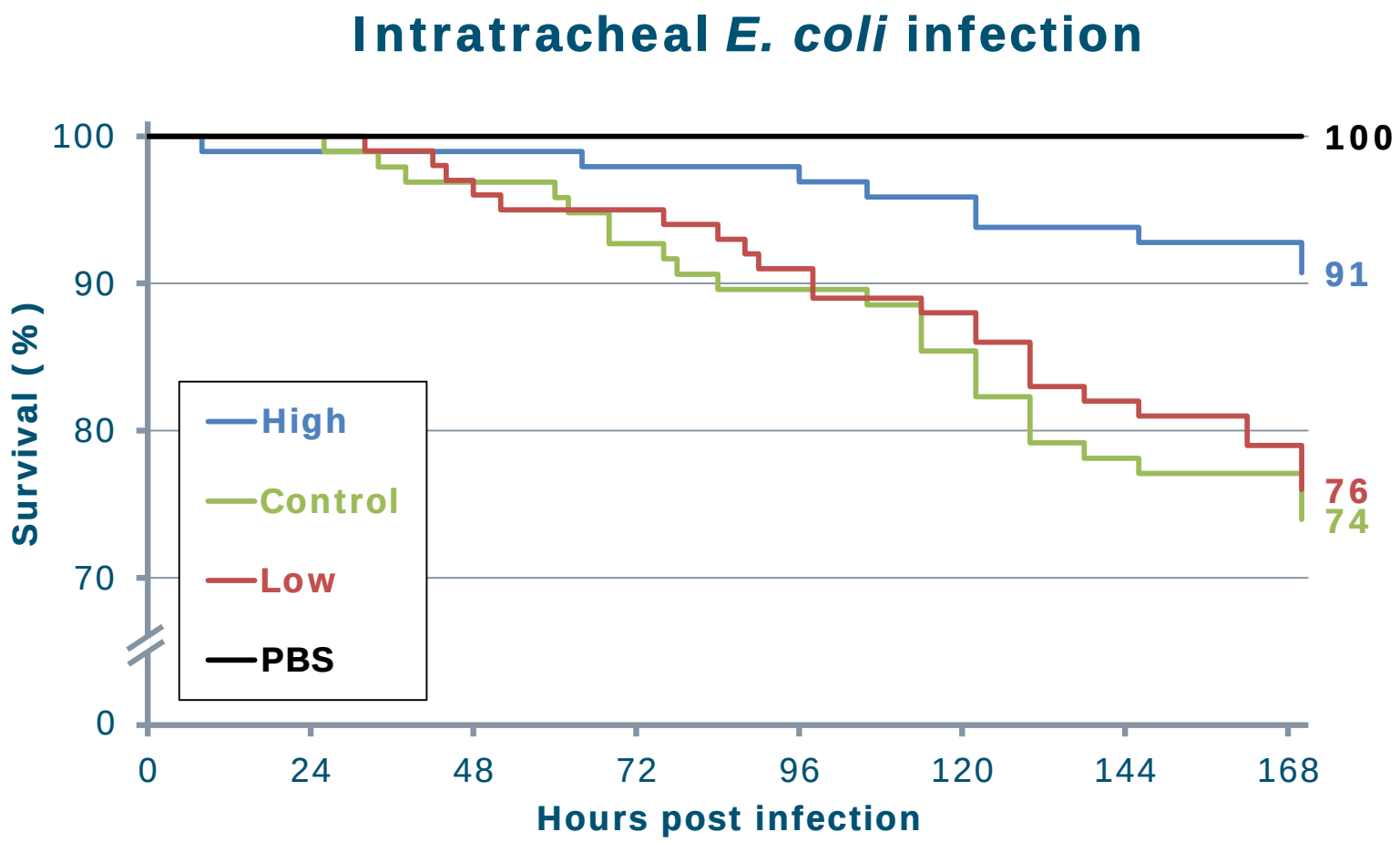
Results



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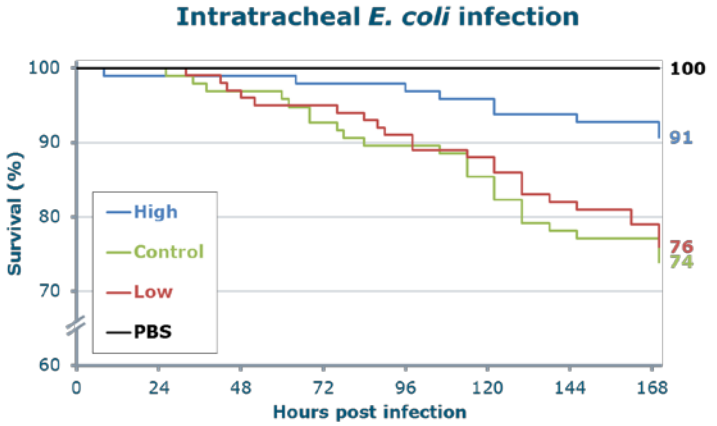
Survival analysis



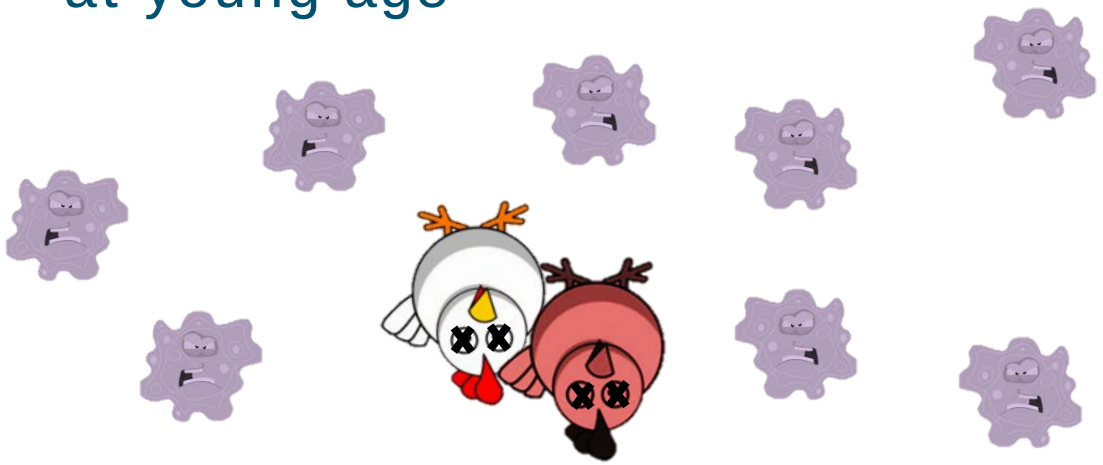
- Cox proportional hazard model
  - Nonparametric test
  - Estimate hazard ratio (HR)

			(95% CI)
High line (G4)	→	HR = 1[a]	
Control line	→	HR = 2.81[b]	(1.31 – 6.04)
Low line (G4)	→	HR = 3.12[b]	(1.46 – 6.69)

Morbidity

Concluding

After 4 generations of divergent selection, we found a significant **lower mortality** of birds selected for **high natural antibody levels** **compared to** birds selected for **low natural antibody levels** as a consequence of an intratracheal ***E. coli* infection** at young age



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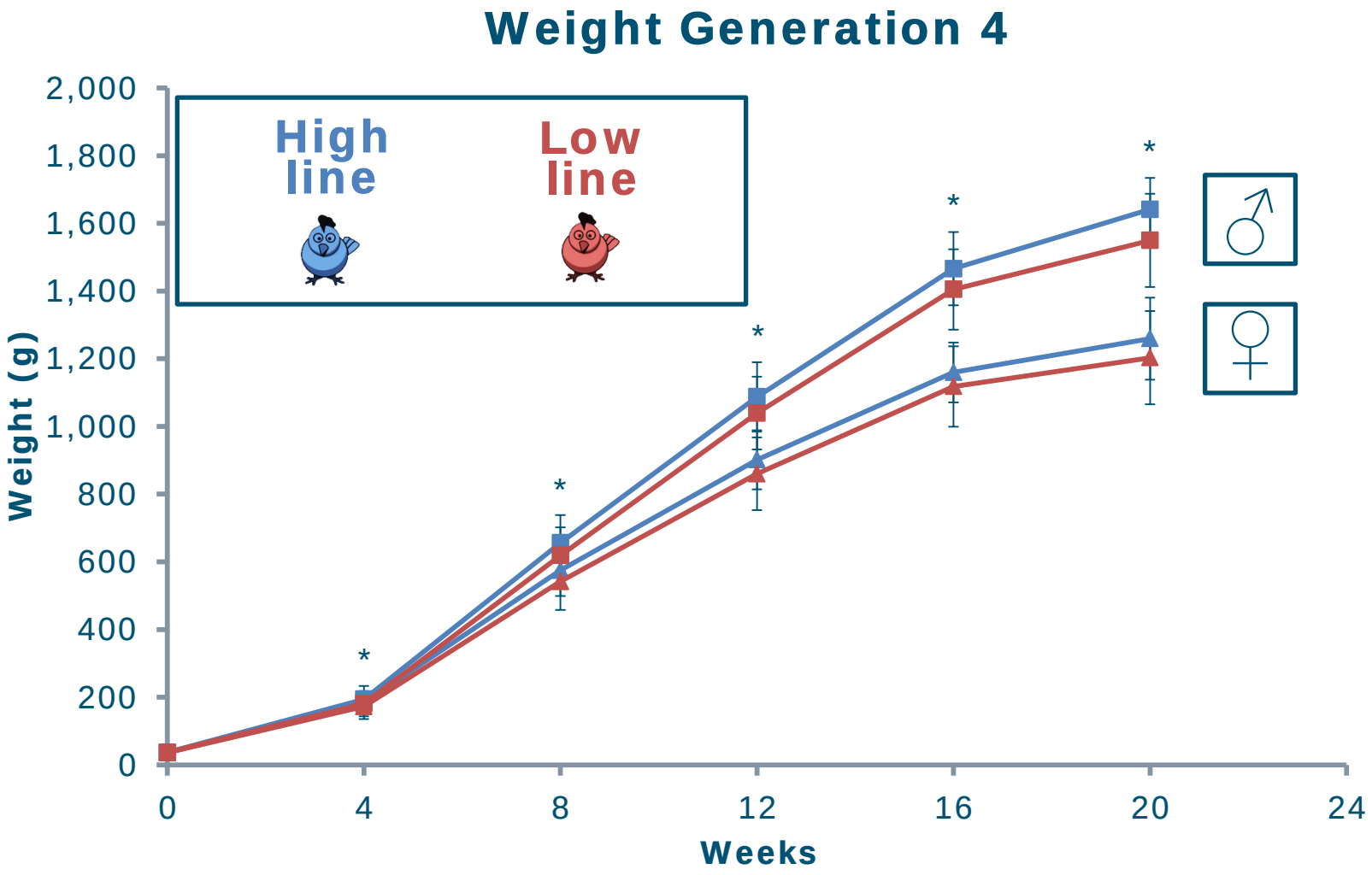
Additional slides

- Growth curve Generation 4 (until 20 weeks)
- Genetic parameters
- NAb VS production

Growth curve Generation 4



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BACK

Genetic parameters

Berghof *et al.*, 2015, PLOS One

Base population

- Purebred ISA WA line
- ~3,700 individuals

	IgTotal	IgM	IgA	IgG
Mean (SD)	7.3 (1.4)	7.5 (1.3)	6.5 (1.3)	6.3 (1.6)
Range (5^{th}–95^{th})	4.9-9.6	5.4-9.7	4.4-8.7	3.7-9.0
σ_p^2 (SE)	1.86 (0.05)	1.27 (0.04)	1.50 (0.04)	1.68 (0.04)
h^2 (SE)	0.12 (0.03)	0.14 (0.05)	0.10 (0.02)	0.07 (0.02)
m^2 (SE)	NS	0.06 (0.02)	NS	NS

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Genetic parameters (II)

Berghof *et al.*, 2015, PLOS One

Base population

- Purebred ISA WA line
- ~3,700 individuals

Phenotypic correlations

	IgTotal	IgM	IgA	IgG
IgTotal		0.55 (0.01)	0.30 (0.02)	0.81 (0.01)
IgM	0.97 (0.03)		0.33 (0.02)	0.26 (0.02)
IgA	0.92 (0.07)	0.81 (0.09)		0.22 (0.02)
IgG	0.96 (0.03)	0.86 (0.09)	0.87 (0.10)	

Genetic correlations

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NAb VS production

Van der Klein *et al.*, 2015, Poultry Science

n = ~2,385	Genetic correlations			
Trait	IgTotal	IgM	IgA	IgG
Body weight (35w)	0.0	-0.0	-0.0	0.0
Egg production (17-24w)	0.1	0.2	0.0	0.1
Egg weight (25-28w, 35-56w, 57-83w)	-0.1	-0.2	-0.1	-0.1
Breaking strength (35-56w, 57-83w)	-0.2	-0.0	0.1	-0.2 [1]
Early eggshell whiteness	0.0	-0.1	-0.2	0.1
FCR (33-43w)	0.3	0.2	0.3	0.3

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NAb VS production (II)

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n = ~2,385	Phenotypic correlations			
Trait	IgTotal	IgM	IgA	IgG
Body weight (35w)	-0.0	-0.0	0.0	-0.0
Egg production (17-24w)	0.0	0.2	-0.1	0.0
Egg weight (25-28w, 35-56w, 57-83w)	-0.0 [1]	-0.1 [1-3]	0.0 [1,3]	-0.0 [1]
Breaking strength (35-56w, 57-83w)	-0.0	-0.0 [2]	0.0 [1]	0.0 [2]
Early eggshell whiteness	0.0	0.0	-0.0	0.0
FCR (33-43w)	0.0	-0.0	0.0	0.0

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