Science Behind the Shield: Vaccination Strategy and Serological Evaluation in Poultry

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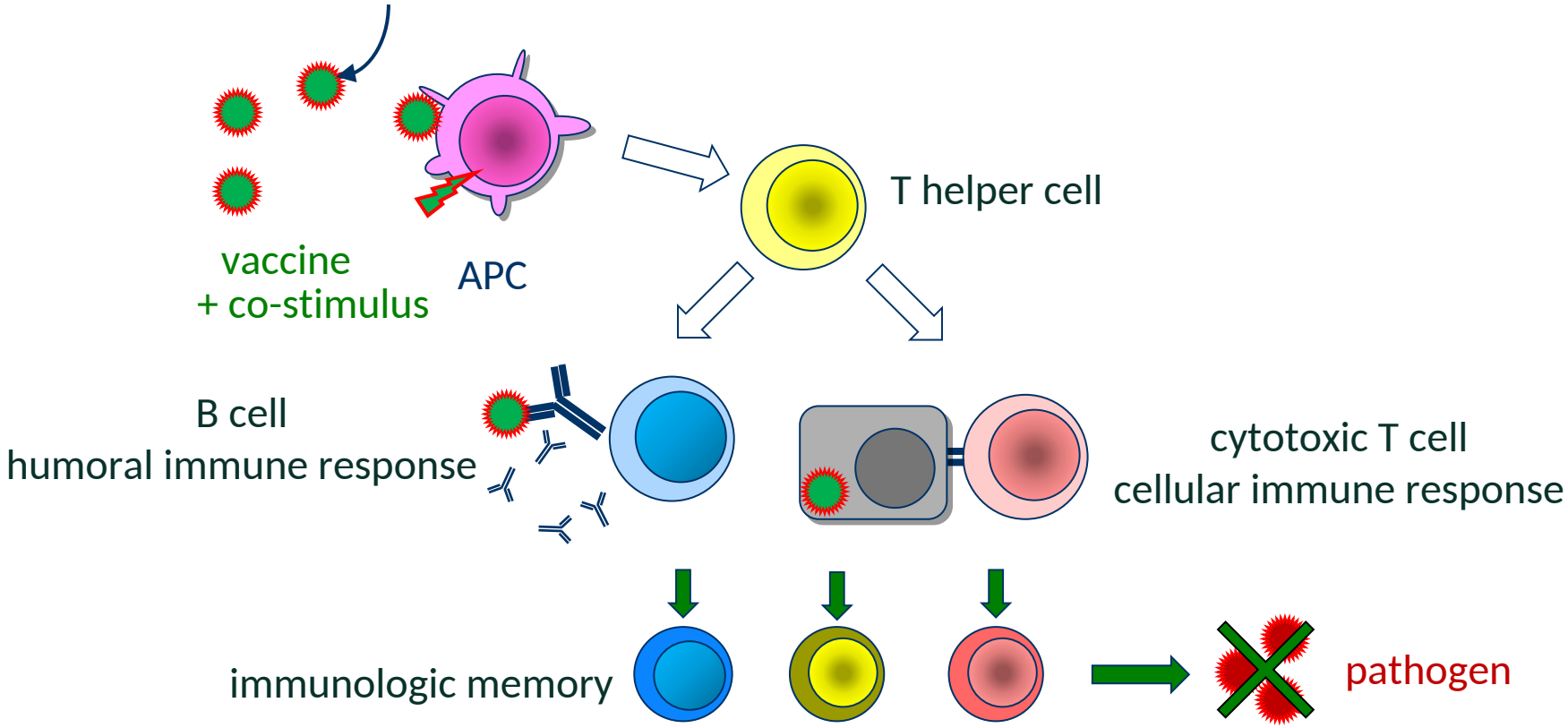
Vaccination Strategy

Vaccination Strategy

What are vaccines and how do they work?

Vaccines prepare the immune system for contact with real pathogens, ideally without causing harm

Vaccines contain parts immunologically identical to the pathogen



Vaccination Strategy

Mucosal and systemic immunity

Systemic immunity: protects the body from circulating pathogens, neutralizing antibodies (IgY, IgA)

Mucosal immunity: protects the environment-host interfaces

Mucosa-associated lymphoid tissue (e.g. Peyer‘s patches, cecal tonsils)

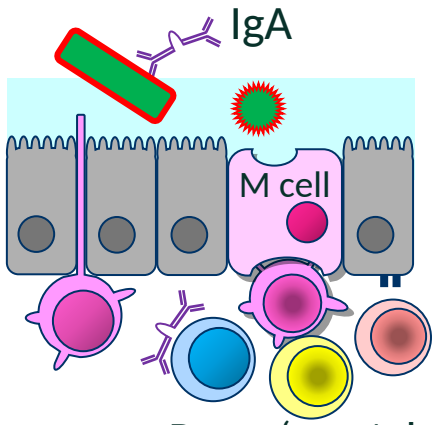
Sampling of mucosal and luminal antigens ≈ spray (lung), drinking water (gut)

Activation of tissue-resident immune cells

Secretion of IgA (some IgY) antibodies into the mucus and lumen

Crosstalk between mucosal and circulating immune cells

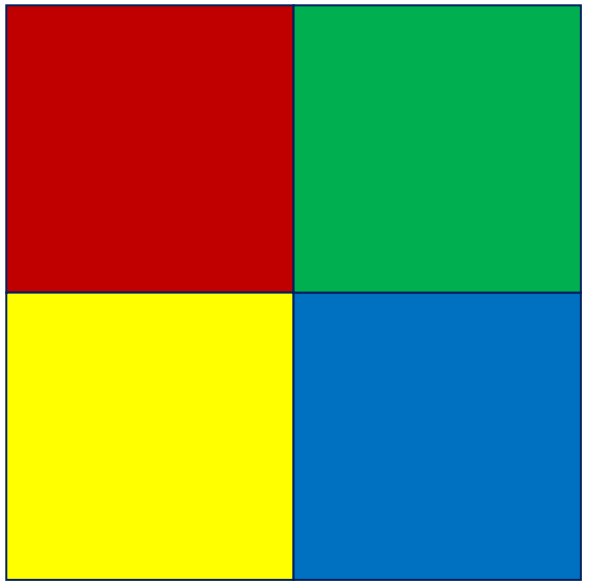
- à tolerance to the mucosal microbiome
- à Limitation of respiratory and enteric infections
- à Priming and modulation of the whole immune system
- à Passive immunity



Vaccination Strategy

What are the main vaccine types?

killed vaccines



(modified) live vaccines

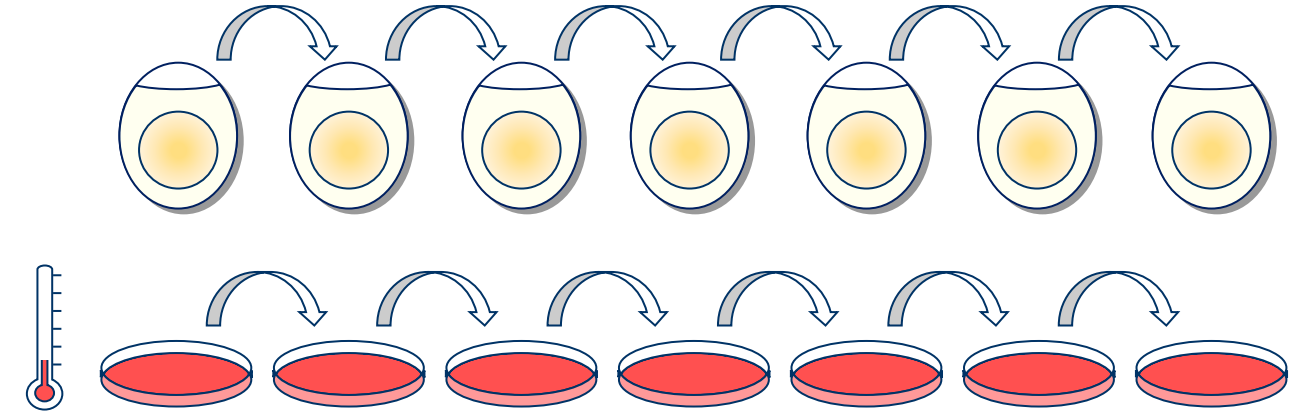
sub-unit vaccines

vector vaccines

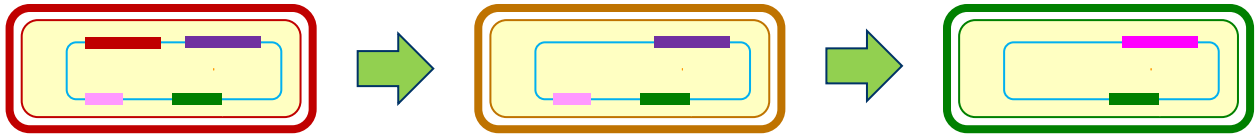
Serological Evaluation – Live full pathogen vaccines

Serological Evaluation – Live full pathogen vaccines

Live vaccines: complete pathogens are attenuated (or not with naturally attenuated pathogens, such as the HVT for example)



by chance in serial passage

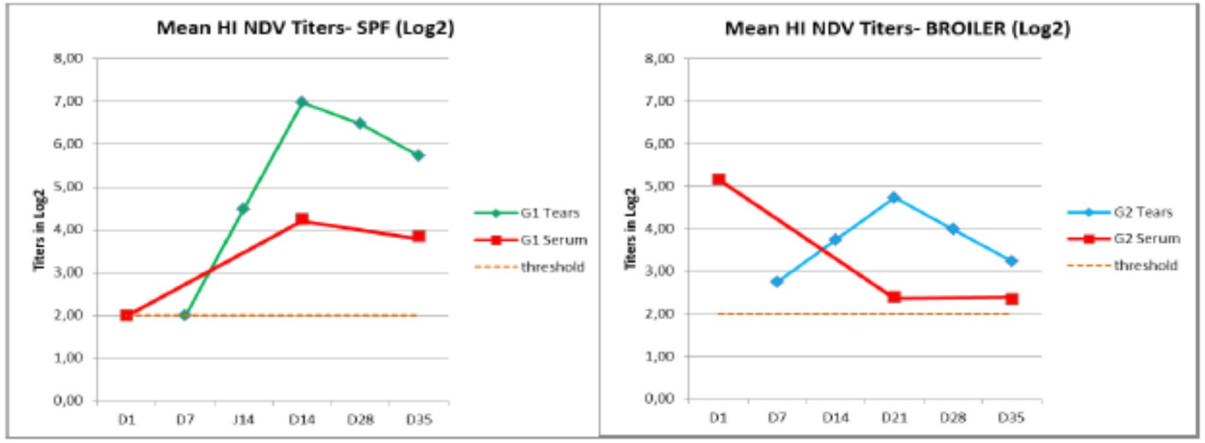


loss of pathogenicity factors

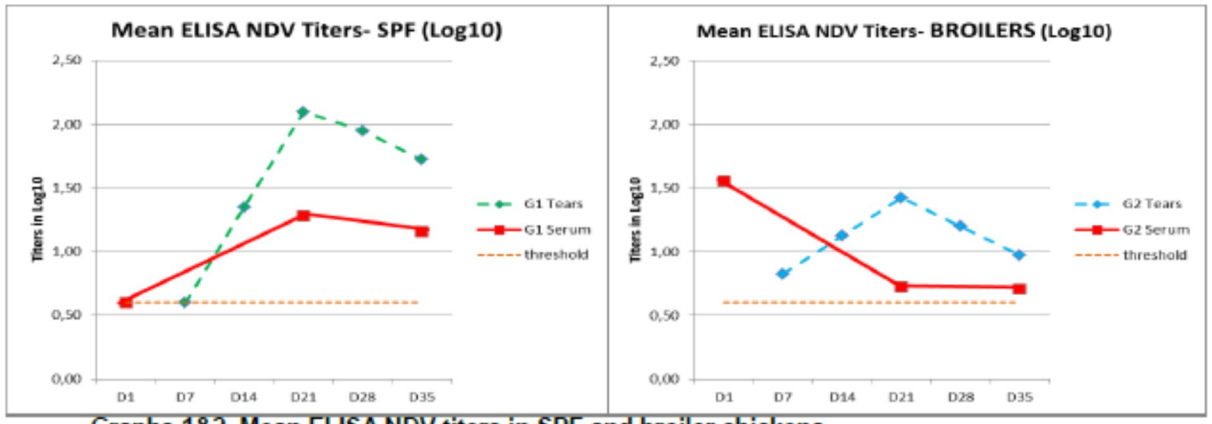
by targeted gene mutation or deletion

Differentiating serological methods in theory possible but not implemented

Serological Evaluation – example of live ND vaccine



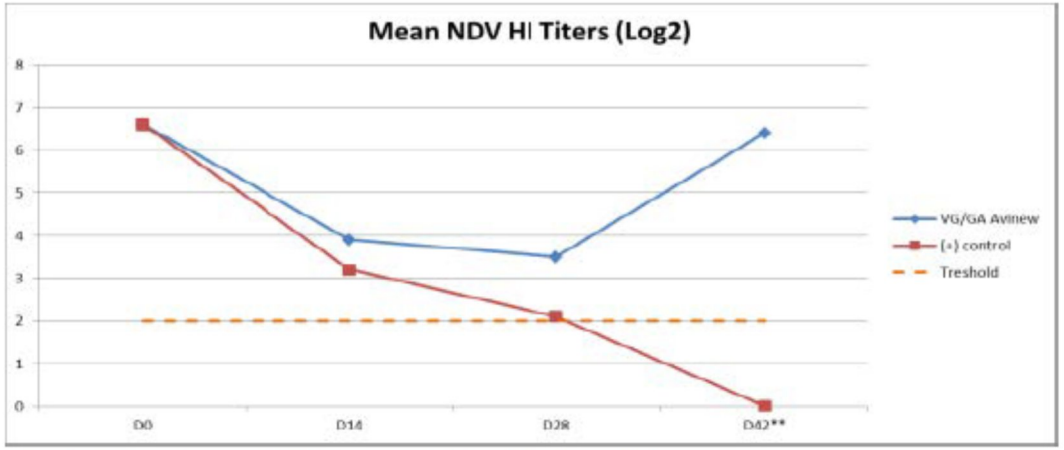
Graphs 3&4. Mean HI test NDV titers in SPF and broiler chickens



Graphs 1&2. Mean ELISA NDV titers in SPF and broiler chickens

Study 2.

Chickens vaccinated with VG/GA vaccine showed a seroconversion at a mean titer of 3.9 at D14, and at 3.5 at D28 of age in presence of maternally-derived NDV antibodies.



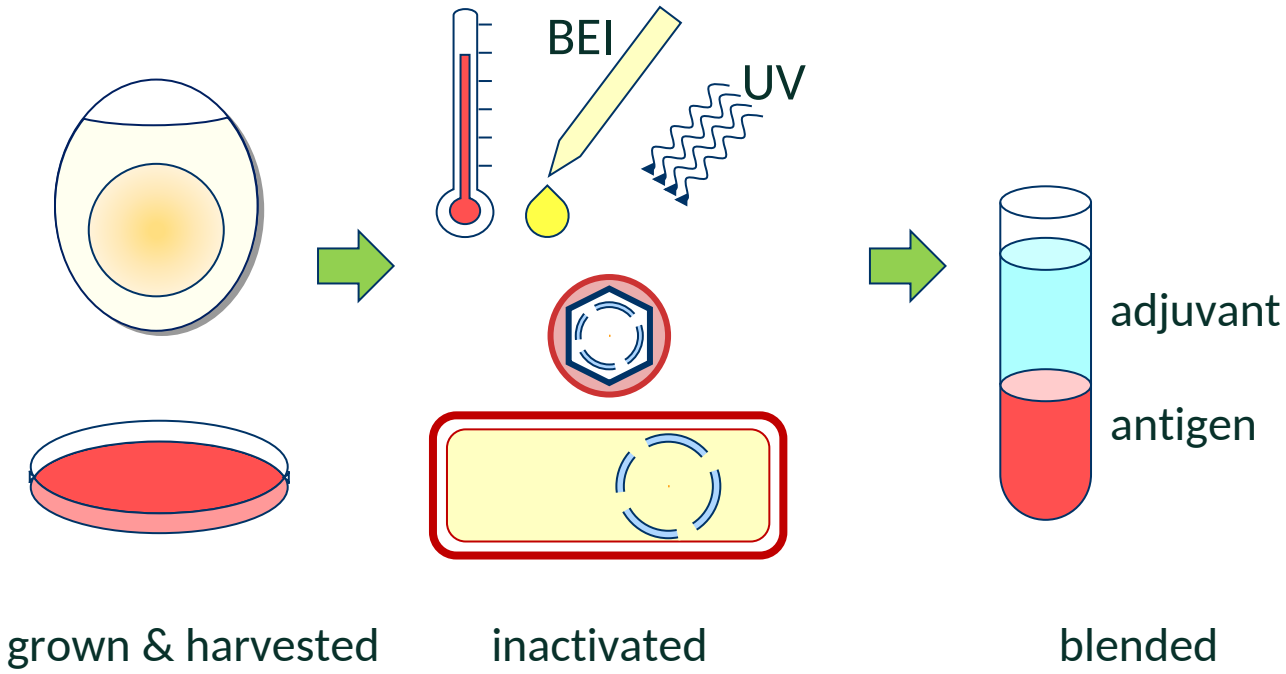
Graph 5. Mean HI test NDV titers in SPF and broiler chickens

Correlation of HI test sero-detection with 92% (11/12) of clinical protection against velogenic Newcastle Disease challenge

Serological Evaluation – Killed full pathogen adjuvanted vaccines

Serological Evaluation - Killed full pathogen adjuvanted vaccines

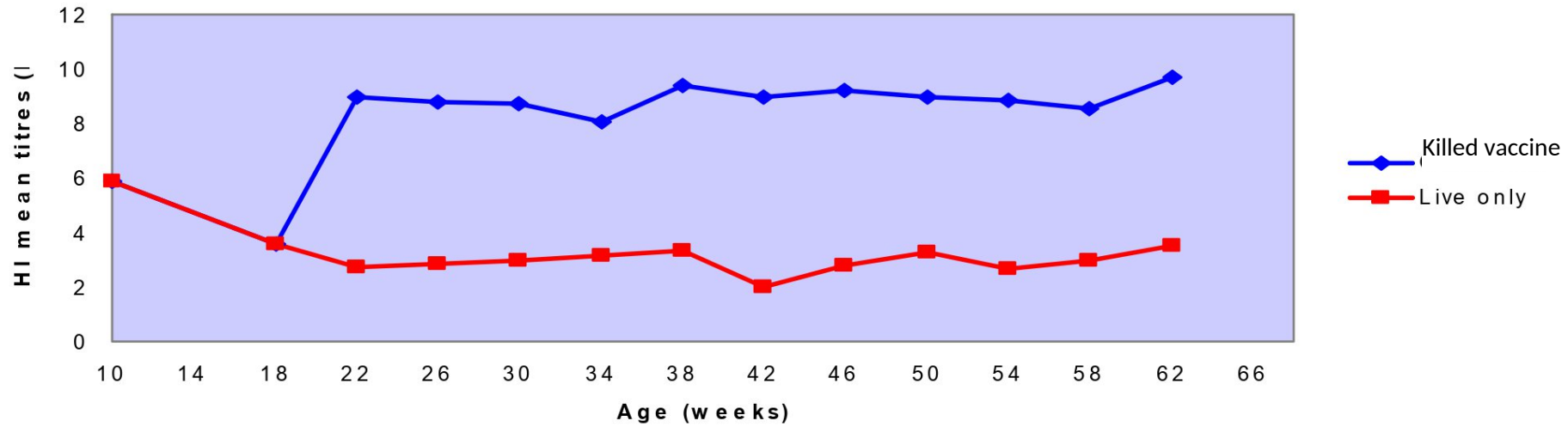
Killed vaccines: complete pathogens or their toxins are inactivated



Sustained serological response after prime-boost or single priming

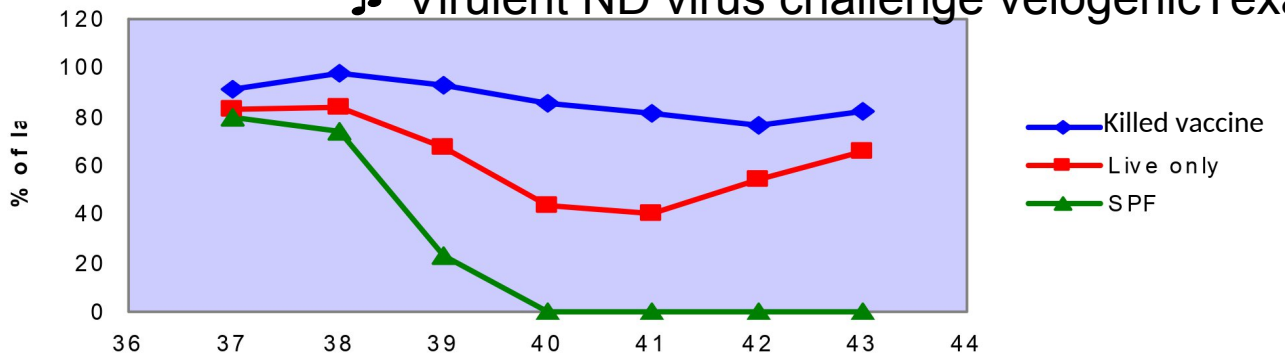
Serological Evaluation – example of prime-boost ND vaccine program

HI test antibody monitoring



% egg production (experimental station)

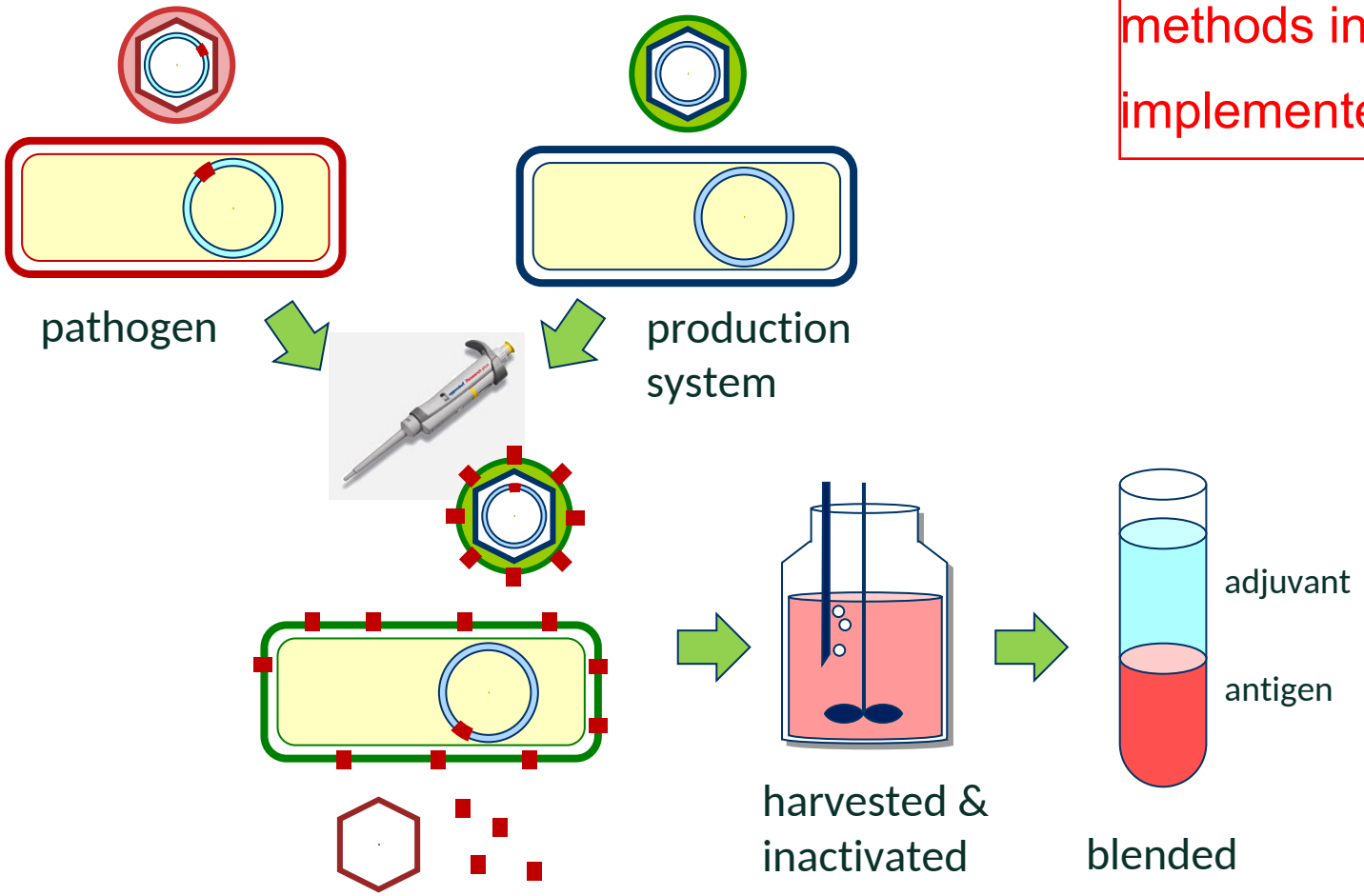
♫ Virulent ND virus challenge velogenicTexas GIV



Serological Evaluation – Sub-unit vaccines

Sub-unit vaccines: selected antigens are expressed:

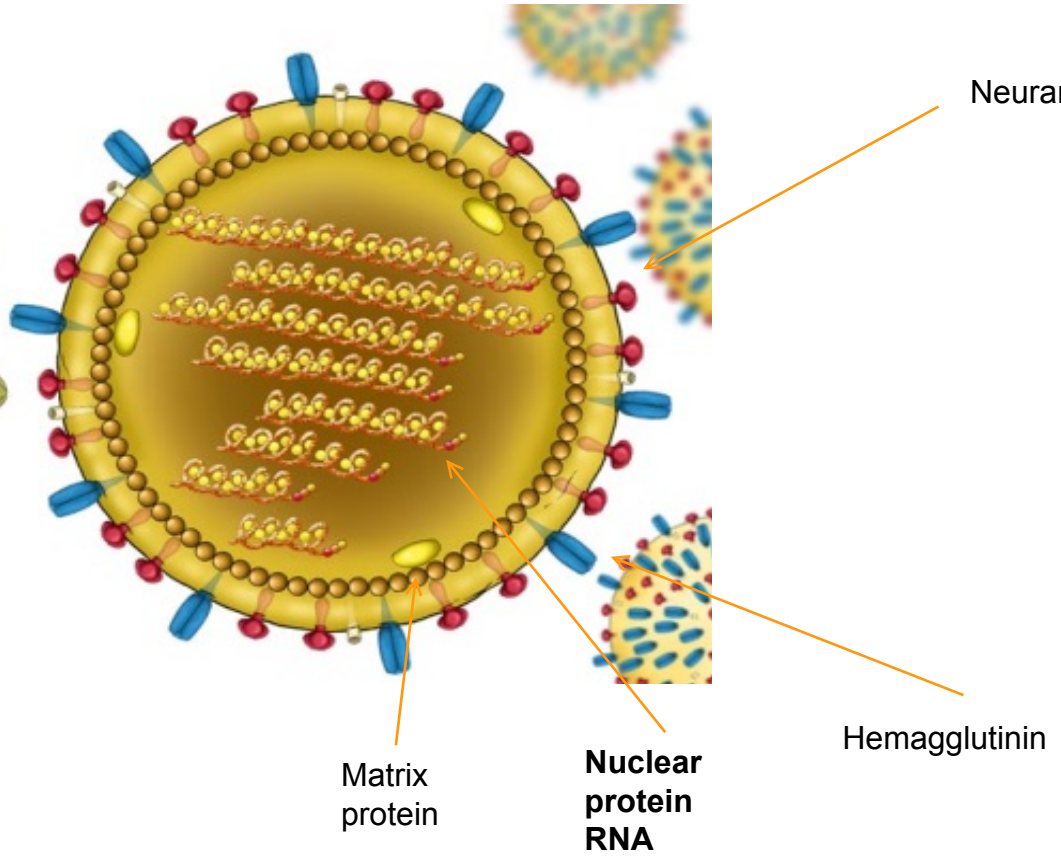
Differentiating serological methods in theory possible and implemented



recombinant system with expressed antigen

Serological Evaluation – example of a AI H5 sub-unit vaccine

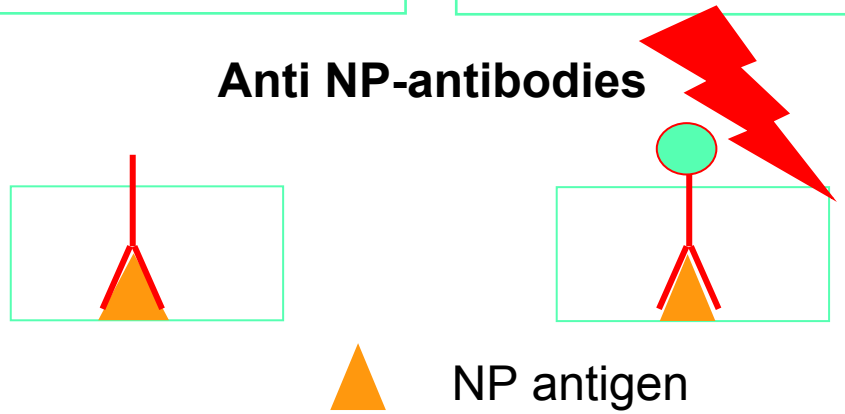
Detection of Vaccinated and subsequently Infected Animals (DIVA-Approach)



- Only infected
- Vaccinated with only HA and infected

- Not infected
- Vaccinated with HA and not infected

Anti NP-antibodies

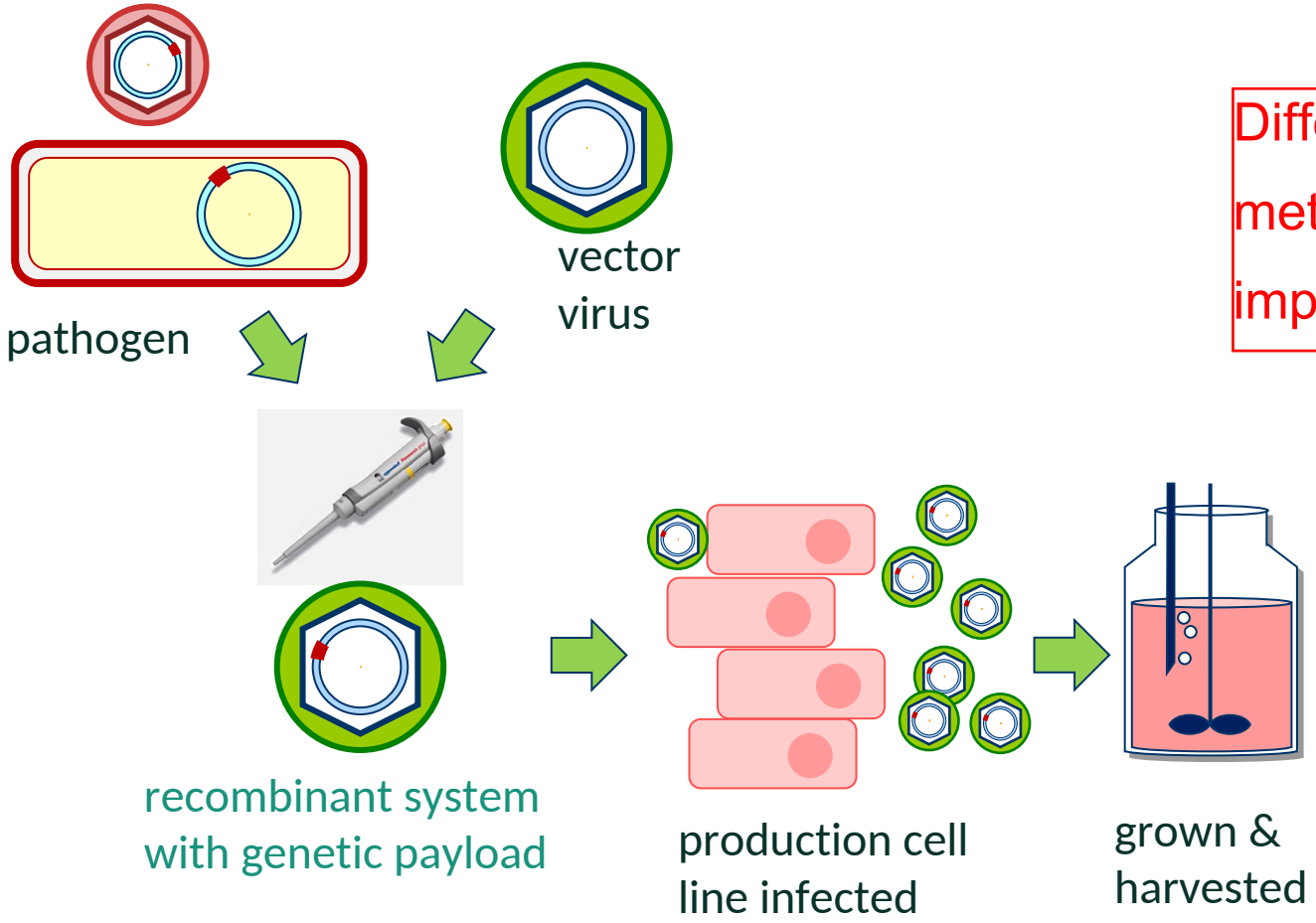


NP antigen

[Mundt, 2012, Encyclopedia of Molecular Mechanism of Disease]

Serological Evaluation – Vector vaccines

Vector vaccines: selected antigen genes are inserted into the vector‘s genome:

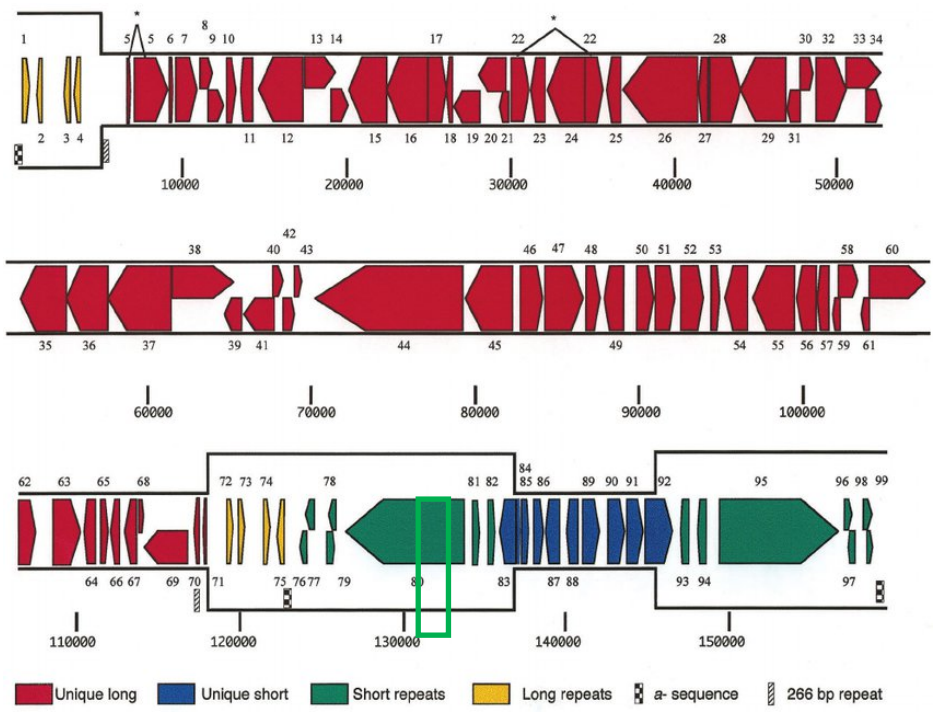


Differentiating serological methods in theory possible and implemented

Serological Evaluation – Vector vaccines

HVT vector vaccine platform

The HVT herpesvirus genome is BIG:



[C Afonso 2001]

What is the best cassette?

Choice of antigen: Vaxxitek VP2 + sequence optimized NDV F VII, modified for better safety and better antigen presentation

Choice of cassette layout: one cassette with connector, or two independent cassettes?

Choice of connector: finding a mistake in literature

Choice of promotor: strength vs stability

… and we need perfect places to insert our extra antigens

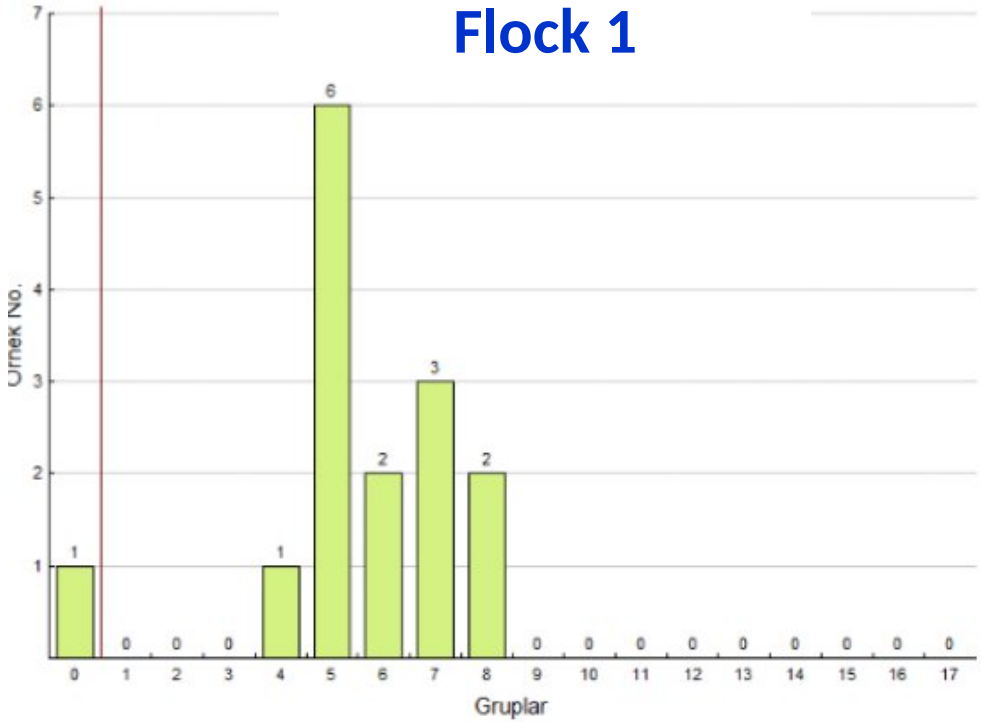
☾ Testing of many insertion sites for viral fitness, antigen expression and efficacy

Serological Evaluation – example of a HVT-IBD vaccine

Validation study – anti-VP2 ELISA titers:

TEST	"STRAIN" DETECTION	POSITIVE (%)	Ct-values range
HVT R-T qPCR	HVT	29/30 (96.6%)	32 - 37

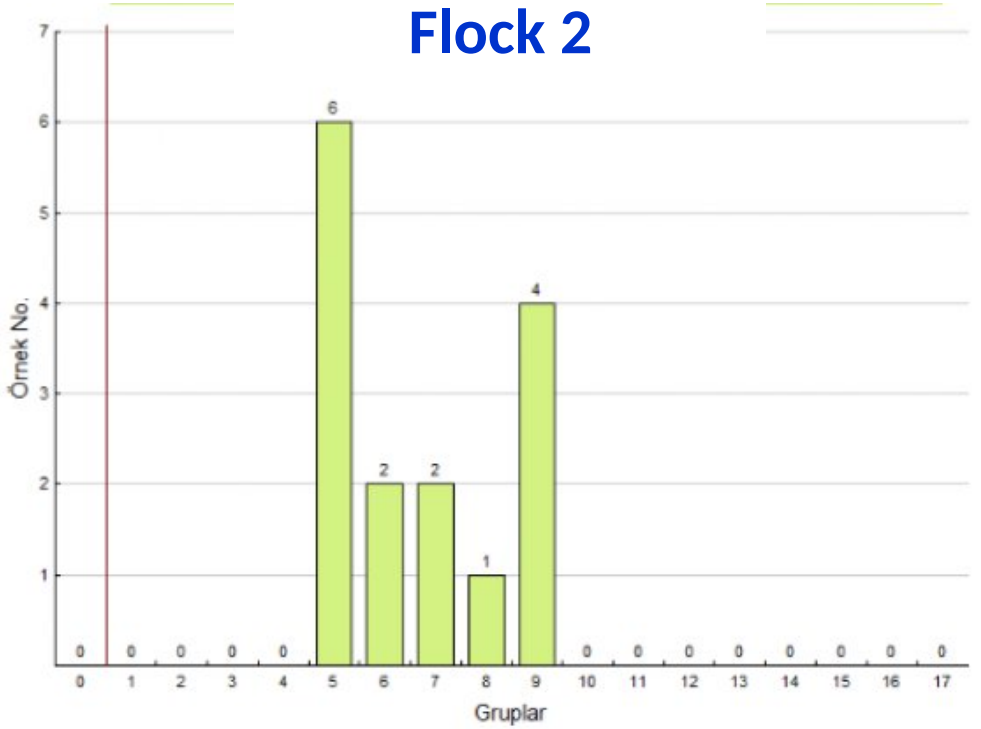
Flock 1



Mean titre	8.223
Minimum	1.285
Maximum	13.574
G.M.T.	7.329
% CV	41

Cut-off = 1324

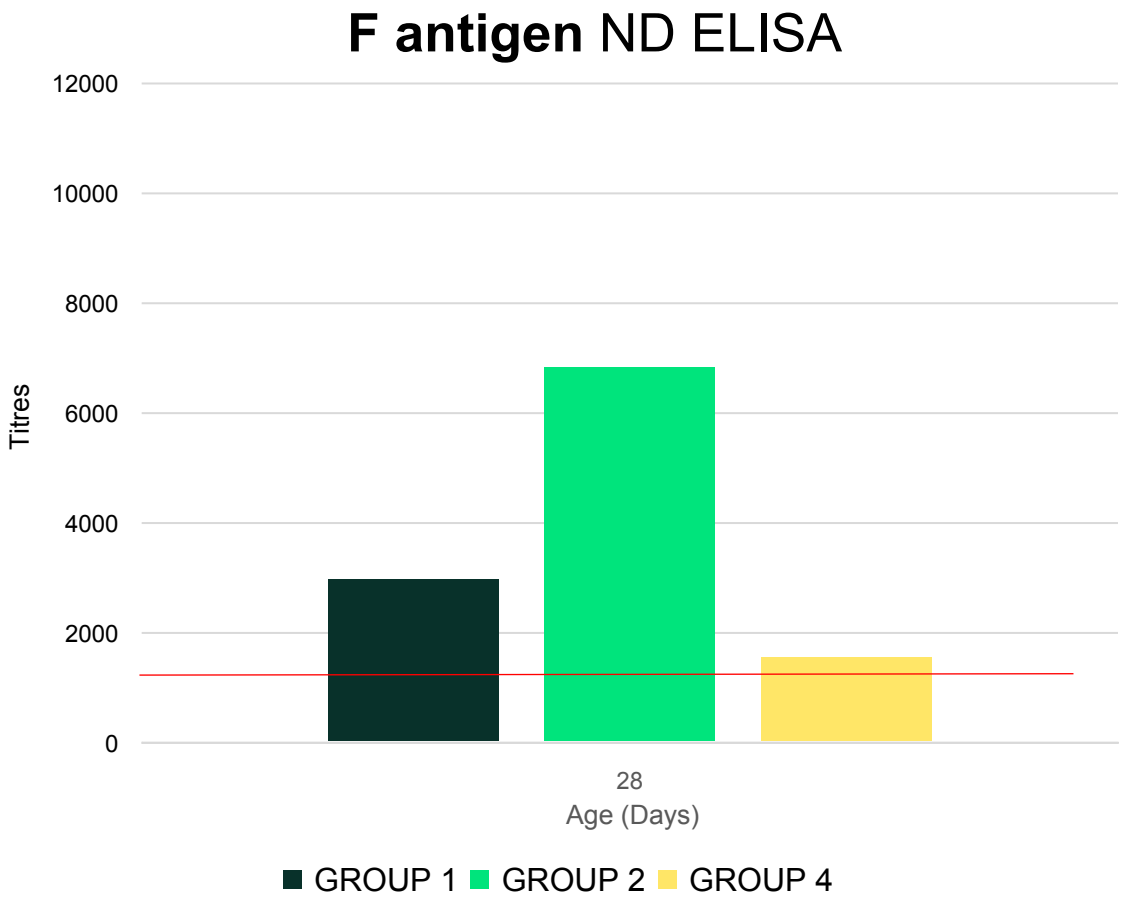
Flock 2

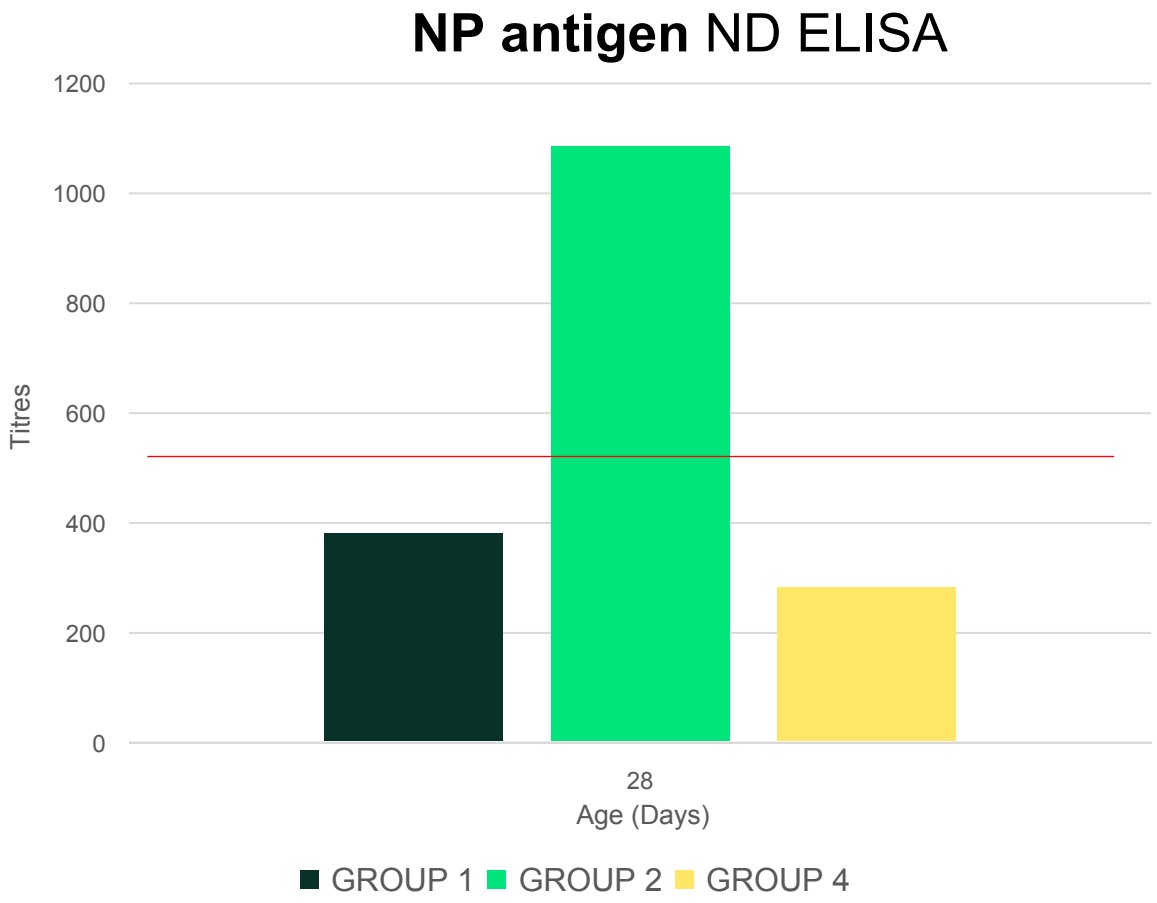


Mean titre	10.335
Minimum	6.254
Maximum	16.084
G.M.T.	9.748
% CV	35

Cut-off = 1324

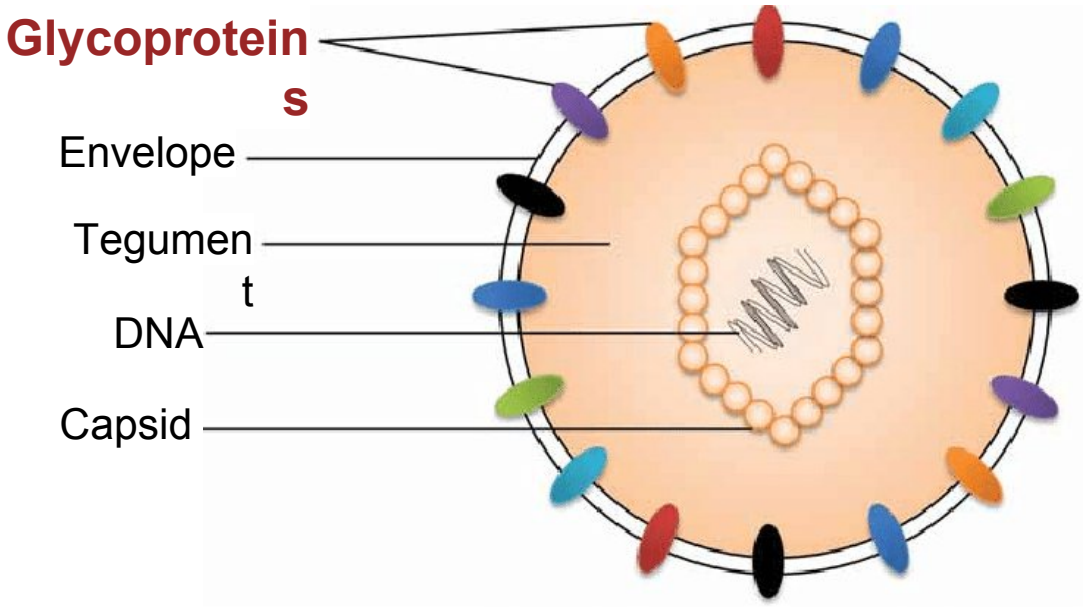
Serological Evaluation – example of a HVT-IBD-ND vaccine





Specific detection of the antigen expressed by the ND F gene insert

Serological Evaluation – example of a HVT-IBD-ILT vaccine

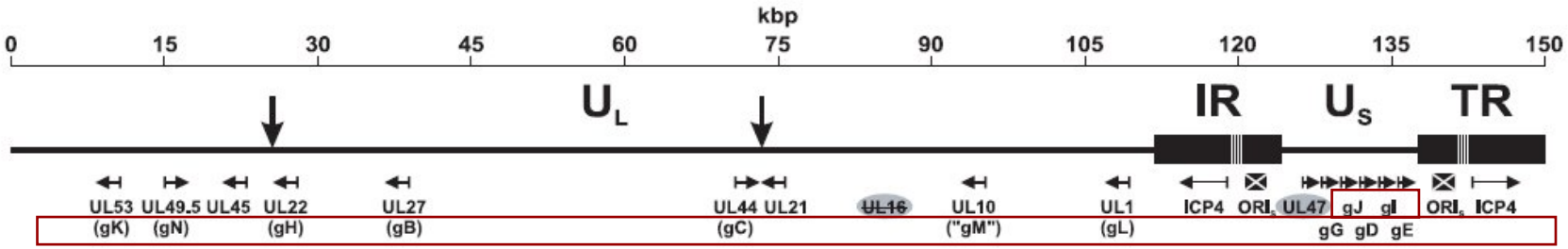


Glycoproteins

≥12: gB, gC, gD, gE, gG, gH, gI, gJ, gK, gL, gM, gN

Various roles: Attachment, entry, fusion, cell-to-cell spread, ion channel, egress, release, tropism

Interactions: gH-gL, gI-gE



Serological Evaluation – example of a HVT-IBD-ILT vaccine

ILT ELISA gD indirect

Commercial quantitative ELISA for the specific detection of ILT gD antibodies
The only test which allows ILT gD recombinant vaccine monitoring
Cut-off number(positive/negative) for all the ELISA kit is 611

RESULTS	STATUS
Titer ≤ 611	NEGATIVE
Titer > 611	POSITIVE

Serological Evaluation

Post-vaccination serological monitoring strategies

In vivo presentation of the antigen (s):

Full inactivated virus (original strain or reverse genetics) vaccines: seroconversions linked to contact with the presented antigens – detectable if no disease challenge and imperfectly detected with disease challenge

Sub-unit vaccines: seroconversions linked to contact with the presented antigen that is usually also expressed by the pathogen – differentiation may be based on other antigen present on the pathogen

Post-vaccination serological monitoring strategies

In vivo expression of the antigen (s):

Viral vectors: seroconversion related to expression of inserted antigens and possibly the vector itself (not classically performed with the HVT vector platform, but in theory possible) – specific ELISA methods to be developed specifically for the vaccine take monitoring and to be used in parallel with classical existing methods suitable for the pathogen antibody detection

RNA vaccines: same approach without the vector effect

Thank you for your attention!