PRESENTATION BROCHURE

MAIN CHALLENGES IN POULTRY FARMING

Vaccination failures

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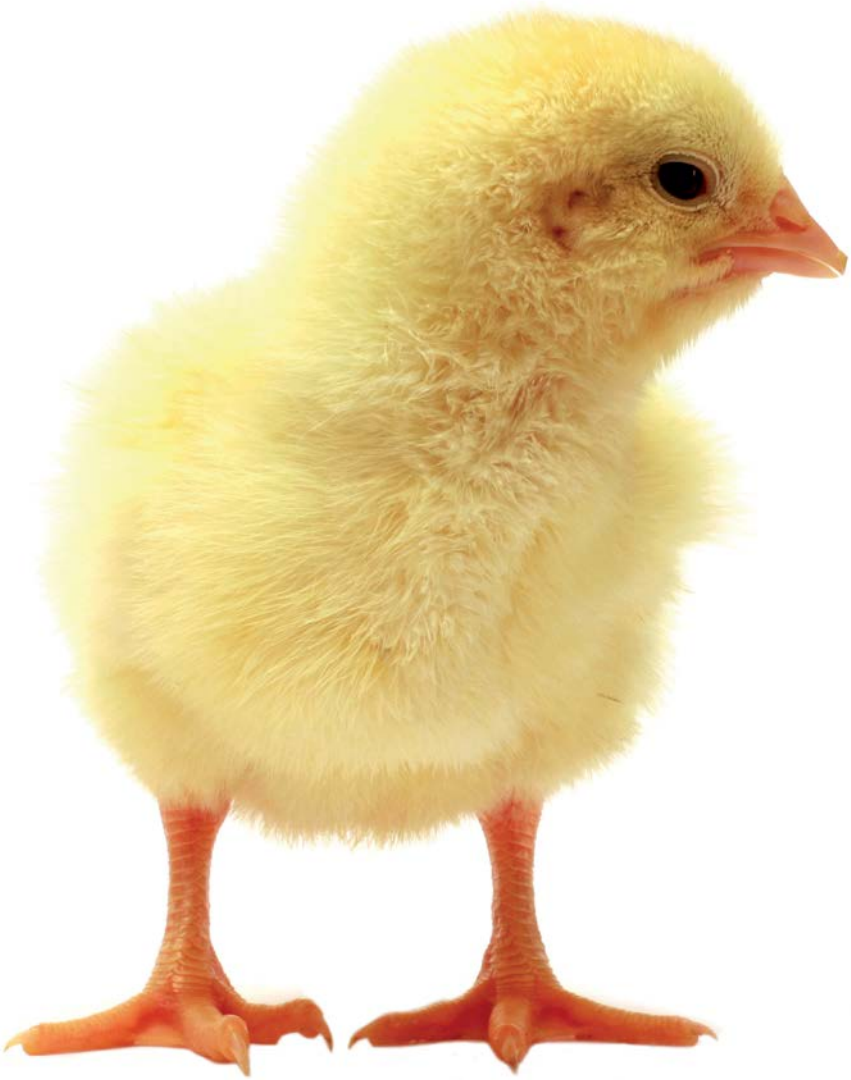
A vaccination failure occurs when the chickens do not develop suitable antibody titer levels and/or are susceptible to a field disease outbreak. Therefore, an updated review (visual-type) has been thoroughly developed in order to highlight the importance of detecting and solving the major vaccination failures in commercial chickens to control diseases affecting this species. The handbook has been written by a prestigious expert with a wide experience in this field. Numerous graphic resources have been included to complement the information provided and make the contents more understandable and accessible to readers.



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Presentation of the book

First ever poultry vaccine was introduced during late 1800 and currently poultry vaccines are widely used in the control of economically important poultry diseases. The aim of the use of vaccines in poultry farming is to reduce the clinical and production impacts of the infections rather than the prevention of various infections. This approach has lead to limitations in poultry viral diseases control using vaccination such as vaccination failures. The causes of vaccine failures may include: (a) emergence of variants or heterogonous strains of pathogens, (b) spread of viral strains used for vaccination among individual birds within the flock and change in virulence level during the bird to bird passage, (c) increased virulence of attenuated vaccine strains linked to reactivation of vaccine virus from latency, and (d) increased virulence of the field viral strains.

Understanding the factors that have lead to vaccine failures and ways of overcoming these limitations are vital to preserve the efficacy of currently used vaccines until novel vaccines or alternative measures for poultry disease control are developed. The objective of this book is to provide an overview of vaccine failures currently experienced in poultry farming globally including causes and scientific reasons, examples and suggested ways of overcoming the issue.

Mohamed Faizal Abdul-Careem

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Dr. Mohamed Faizal Abdul-Careem is Associate Professor (virology) at the University of Calgary (Canada) since 2010. He has obtained his basic veterinary degree (BVSc) from the University of Peradeniya (Sri Lanka) and a Master of Veterinary Medicine degree (MVM) from the University of Glasgow Veterinary School (UK) in 1995. He completed his PhD degree from the University of Guelph (Canada) in 2008. His doctoral thesis entitled "Characterization of Host Responses Following Marek's Disease Virus Infection or Vaccination Against Marek's Disease". Following his PhD degree, he was awarded a prestigious Canadian Institutes of Health Research Fellowship to conduct post-doctoral research on innate immune responses generated against mucosal viral infections at the Center for Gene Therapeutics of the McMaster University (Canada). He is diplomate of American College of Poultry Veterinarians (ACPV) and American College of Veterinary Microbiologists (ACVM).

He has expertise and strong interests in the area of avian viral immunology. He has around 37 manuscripts published in peer-reviewed journals and 90 % of these manuscripts are on avian viral immunology. His research programme at the University of Calgary is supported by grants from Canadian federal, provincial and poultry industry sources such as Natural Sciences and Engineering Research Council of Canada, Alberta Livestock and Meat Agency (ALMA), and Canadian Poultry Research Council. He has established state-of-the-art research facility for his experimental animal and laboratory work at the University of Calgary.

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Mohamed Faizal Abdul-Careem

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First ever poultry vaccine was introduced during late 1800, and currently poultry vaccines are widely used for the control of economically important poultry diseases. Most probably, chickens are the most vaccinated farm animal species today; an average broiler chicken may receive up to eight vaccinations whereas an average commercial layer chicken may receive up to 12 vaccinations during their short production cycles. An average breeder chicken may receive up to 20 vaccinations. The aim of the use of vaccines in poultry farming is to reduce the clinical and production impacts of the infections rather than the prevention of various infections. This approach along with the heavy use of vaccines in poultry farming has lead to limitations in poultry viral disease control using vaccination such as vaccination failures.

Significance of poultry infectious diseases

Currently, an array of vaccines is employed for the control of viral, bacterial and parasitic diseases in chickens.

Table 1. Aetiological agents of economically important poultry infectious diseases that are controlled employing various means including vaccination.

Viruses	Bacteria	Parasites
◗ Infectious bronchitis virus. ◗ Infectious bursal disease virus. ◗ Infectious laryngotracheitis virus. ◗ Newcastle disease virus. ◗ Chicken anaemia virus. ◗ Marek's disease virus. ◗ Avian leucosis virus. ◗ Avian encephalomyelitis virus. ◗ Inclusion body hepatitis virus. ◗ Egg drop syndrome virus.	◗ *Salmonella* species. ◗ *Escherichia coli.* ◗ *Clostridium* species. ◗ *Mycoplasma* species. ◗ *Haemophilus paragallinarum.* ◗ *Bordetella* species. ◗ *Chlamydia* species. ◗ *Pasteurella multocida.*	◗ *Eimeria* species. ◗ Helminths.

Infectious diseases caused by these aetiological agents may represent around 30 % of the issues faced by the poultry industry in the world.

Control options for poultry infectious diseases

Of the measures employed for the control of poultry infectious diseases, vaccination has gained increasing attention when compared to use of antimicrobials and biosecurity measures.

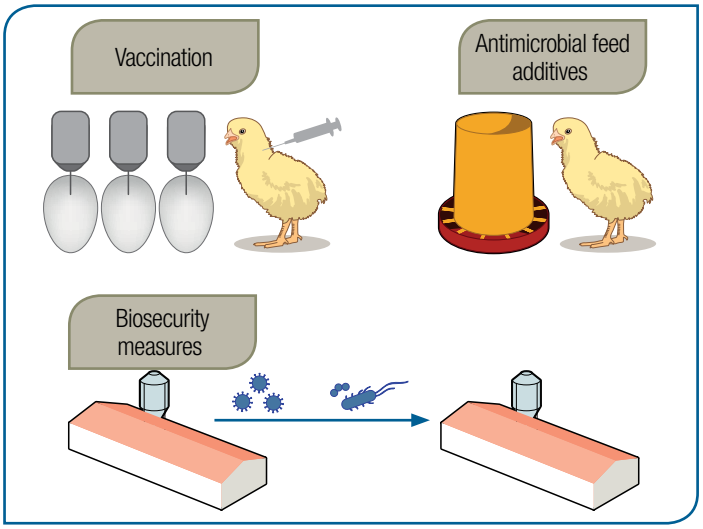

Figure 1. Current measures employed for poultry infectious disease control.

General definition of vaccination

Vaccination involves administration of antigens in terms of whole pathogen or a related organism (attenuated or killed) or parts of the pathogen with a view of eliciting protective adaptive immune responses against the pathogen mimicking the development of naturally acquired immune responses. The goal of this artificial induction of immune responses is to protect the animals against infectious diseases.

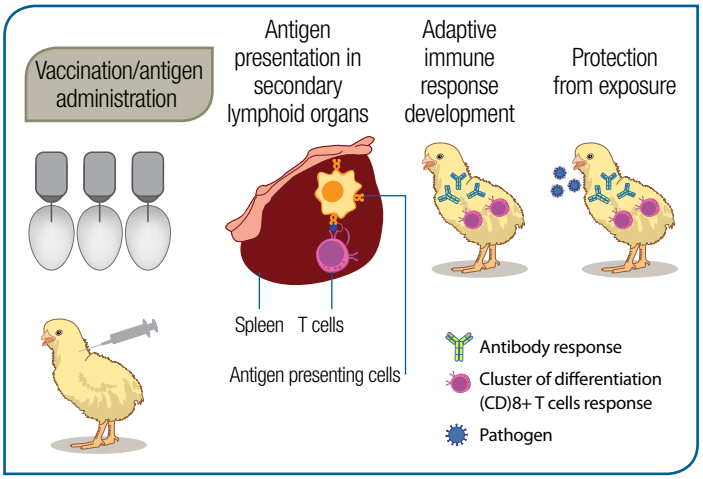

Figure 2. Vaccination involves antigen administration leading to antigen presentation and development of protective adaptive immune responses.

History of poultry vaccines and vaccination

In 1879, Louis Pasteur accidentally produced the first ever laboratory-developed vaccine: that happened to be the vaccine for fowl cholera in chickens. This landmark discovery followed the production and licensing of number of poultry vaccines that are summarized in the Figure 3.

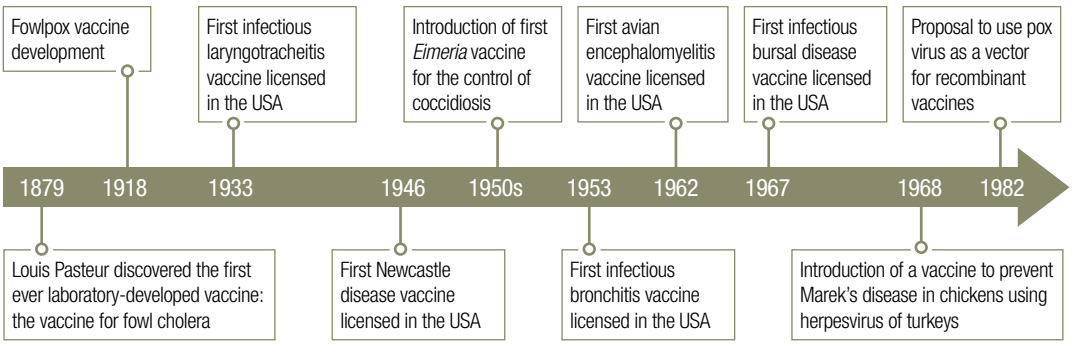

Figure 3. Important discoveries related to poultry vaccines since first description of the fowl cholera vaccine in late 1800.

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Economic benefits of vaccination

Poultry infectious diseases cause significant economic impacts; in commercial layers, broiler breeders and backyard flocks, losses are due to decrease in egg production, immune suppression, poor weight gains and mortality, whilst in commercial broilers, production losses are due to immune suppression, poor weight gains, carcass condemnation at processing and mortality.

Table 2. Losses due to infectious diseases could be reduced by vaccination in chickens.

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Status of vaccination against infectious diseases	◗ Commercial layers ◗ Broiler breeders	Commercial broilers	Backyard flocks
Vaccinated chickens 	Protection from immune suppression, production losses and mortality.	Protection from immune suppression, bodyweight loss, mortality and carcass condemnation.	Protection from immune suppression, production losses and mortality.
Unvaccinated chickens 	Outbreaks with up to 100 % mortality rates, immune suppression and production losses.	Immune suppression, bodyweight loss, mortality and carcass condemnation.	Immune suppression, production losses and mortality.

- The aims of poultry vaccines are to improve the health and welfare of poultry species and increase poultry meat and egg production in a cost-effective manner. These aims have led to the development of poultry vaccines from whole-pathogen preparations (attenuated or killed) to genetically engineered DNA and recombinant vaccines.
- Additionally, some of the vaccines used for the control of Marek's disease (MD) in chickens contain herpesvirus of turkeys (HVT) and SB-1 strains of herpesviruses which are non-pathogenic and do not require attenuation in the laboratory. Lentogenic viral strains used against Newcastle disease (ND) and pigeon pox virus used against fowlpox are some other examples of live non-attenuated vaccines used in poultry flocks. Live *Eimeria* organisms are also used without attenuation for the control of coccidiosis in chickens.

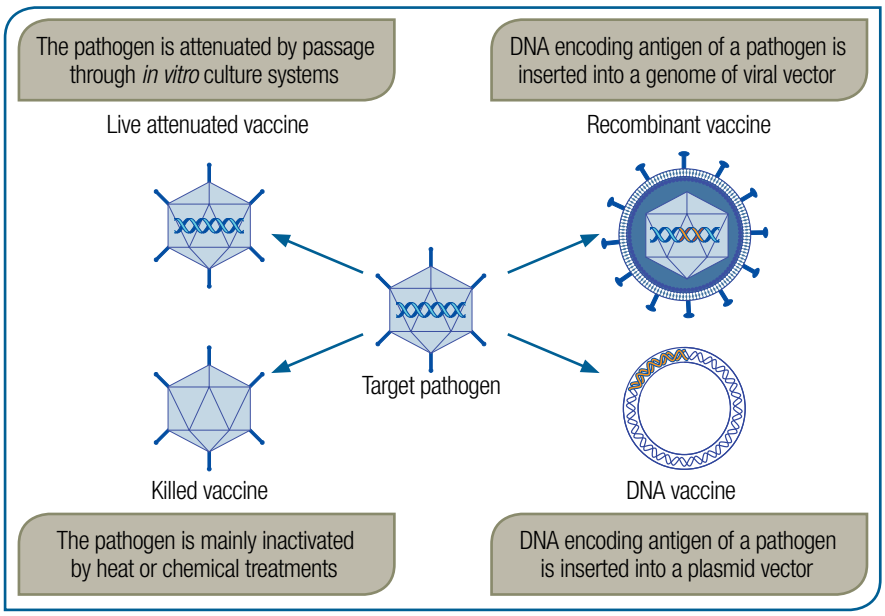

Figure 4. Major types of poultry vaccines that are available or currently in development for poultry infectious disease control.

Killed vaccines

Most of the poultry killed vaccines are developed against viral diseases. The inactivation of the virus is done via heat or chemical treatments. Although the killed vaccines are stable, the non-infectious nature of the killed vaccines reflects in the quality of the vaccine induced adaptive immune responses. Since they are only able to stimulate antibody-mediated rather than both cell- and antibody-mediated immune responses, the generated immune responses are weak, require multiple vaccine administrations and the vaccine formulations require combining with expensive adjuvant compounds. In general, killed vaccines are used aiming to control clinical signs of a disease rather than infection following vaccination.

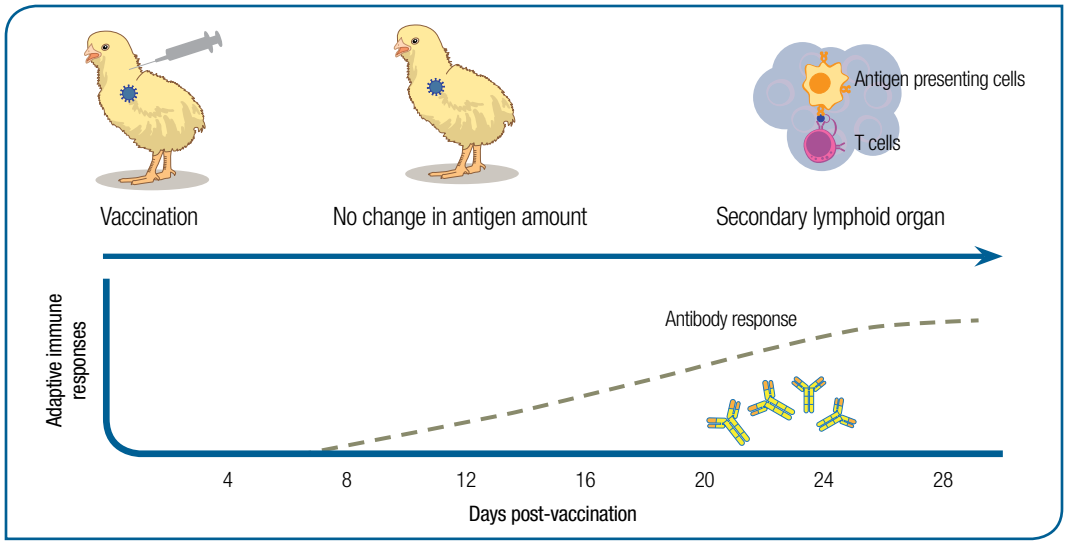

Figure 5. Non-infectious nature of killed vaccines results antibody-mediated adaptive immune responses rather than CD8+ T cell-mediated immune responses following vaccination.

Live attenuated vaccines

There is an array of poultry live attenuated vaccines that are developed against poultry viral diseases. The attenuation of the virus is done via series of cell culture or embryo passages. Passage of the virus may induce random mutations leading to reduced virulence. Since the attenuated viral strains are able to replicate in the host inducing mild infection, it will lead to both cell- and antibody-mediated immune responses without an adjuvant combination. The potential limitations of theses vaccines are residual virulence and reversion of the virulence.

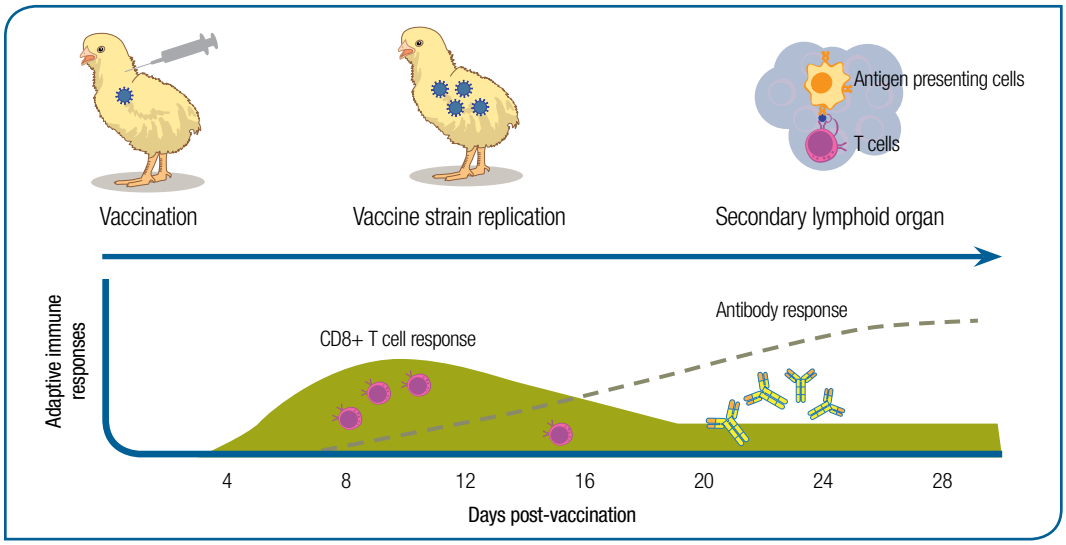

Figure 6. Infectious nature of live attenuated vaccines leads to both antibody- and cell-mediated immune responses following vaccination.

DNA vaccines

The DNA encoding an antigen of a pathogen is inserted to vector plasmid and naked DNA with the insert is used for vaccination. Since the antigen of interest is produced within the animal and presented, the vaccination elicits both cell- and antibody-mediated immune responses. It is also possible to insert genes of antigens of multiple pathogens into one plasmid vector and number of vaccinations in poultry could be reduced. Due to the stability of the vaccine in various environmental temperature conditions, this type of vaccines is ideal for resource poor settings. Although experimental data is available to support the success of this technology in chickens, currently no DNA vaccines are available commercially for poultry infectious disease control.

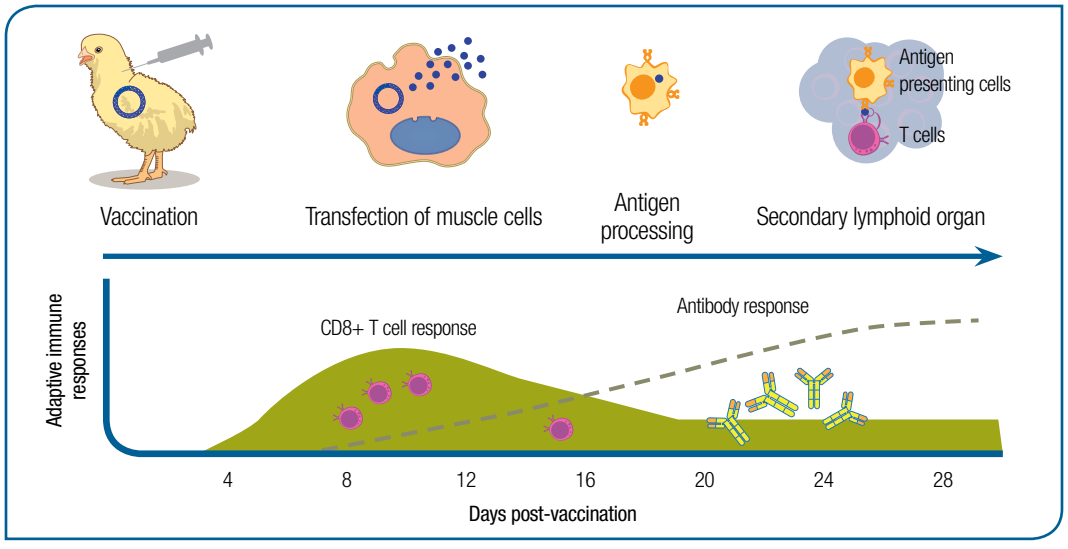

Figure 7. DNA vaccination results in antigen of interest being produced within myocytes and recognized by antigen presenting cells and presented. The DNA vaccination elicits both cell- and antibody-mediated immune responses.

Recombinant vaccines

Poxviruses and herpesviruses, as vectors, can accommodate large number of genes of antigens derived from various pathogens and can infect avian cells, resulting in the expression of these encoded proteins. Since the antigen of interest is produced within the animal and presented, the vaccination elicits both cell- and antibody-mediated immune responses. Currently, a number of commercial recombinant poultry viral vaccines is available for infectious disease control in chickens.

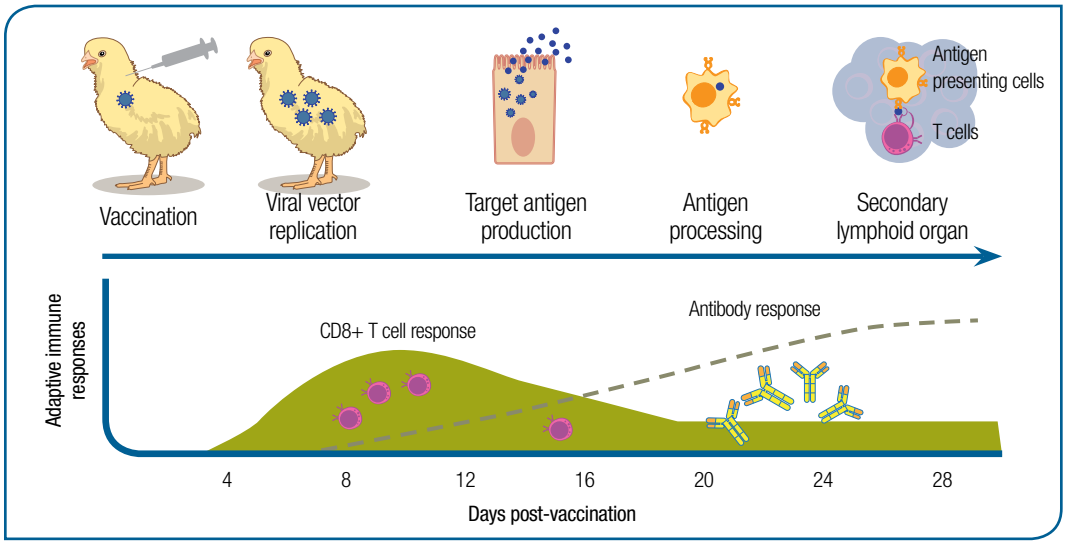

Figure 8. The viral vector carrying gene encoding antigen of pathogen replicates in chicken, expresses the antigen, presented, and both antibody- and cell-mediated immune responses are generated following vaccination with recombinant vaccines.

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