Coccidiosis in poultry: pathogenesis, immune response and challenges

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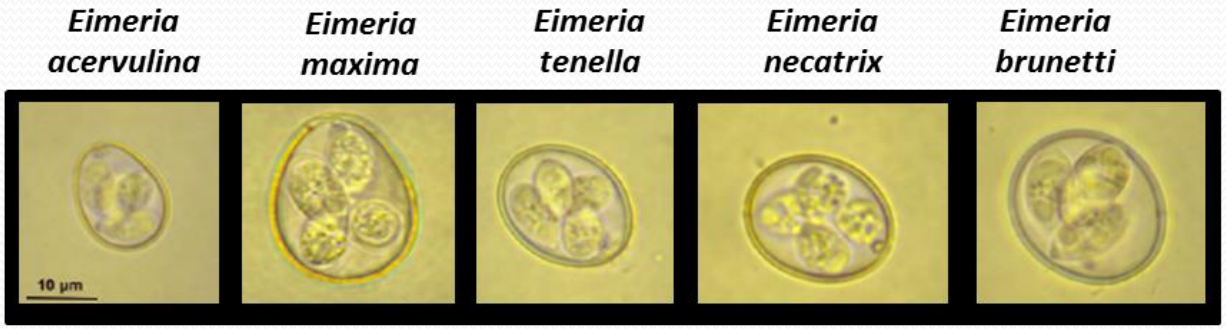
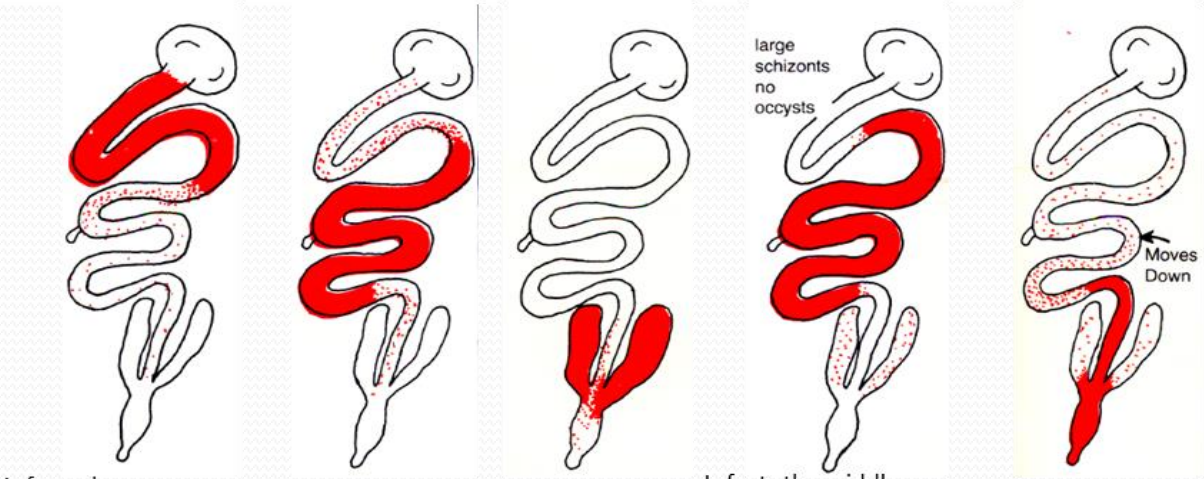
(Ph.D; PDF)

Introduction

- India presently holds **3rd** position in the world in egg production.
- Poultry meat production in india about **2.2 million tons** per year.
- About **3 million** people in India are directly linked to the poultry industry contributing $5.7 billion annually to the national(A. K. Tewari and B. R. Maharana, 2014).
- Losses due to coccidiosis costs the global poultry industry in excess of **£500M** per annum (Shirley et al. 2013).
- Coccidiosis is an intestinal protozoan infection caused by **seven** species of the genus ***Eimeria*** viz *E. tenella, E. necatrix, E. brunetti, E. maxima, E. acervulina, E. mitis* and *E. praecox,* infect chickens in order of their pathogenicity and each species is unique both immunologically and its ability to parasitize specific portion of GI tract causing different pathological and clinical signs.

Five common species of *Eimeria* associated with coccidiosis in chicken (Reid, W.M., and P.L. Long, 1979)

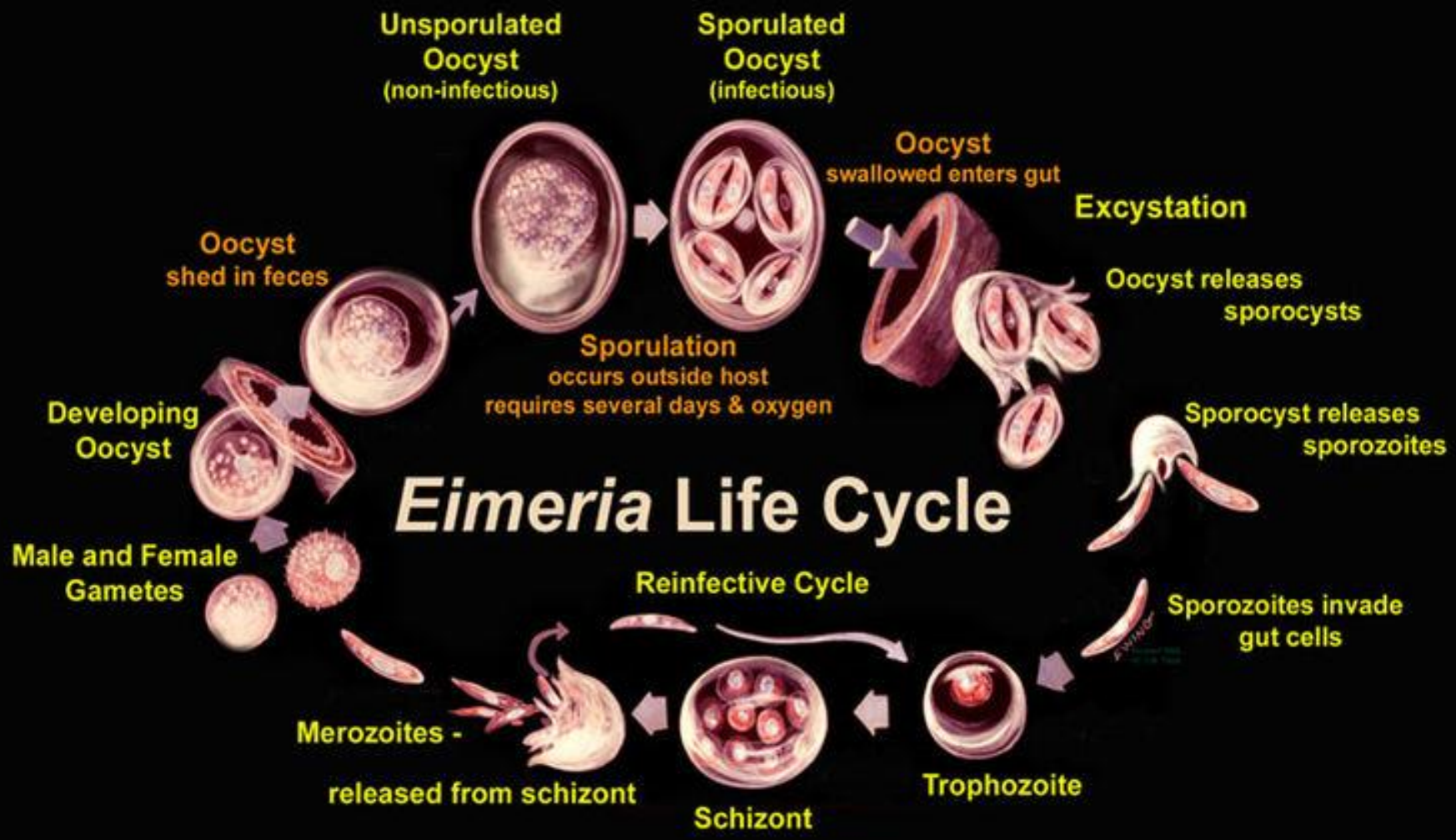




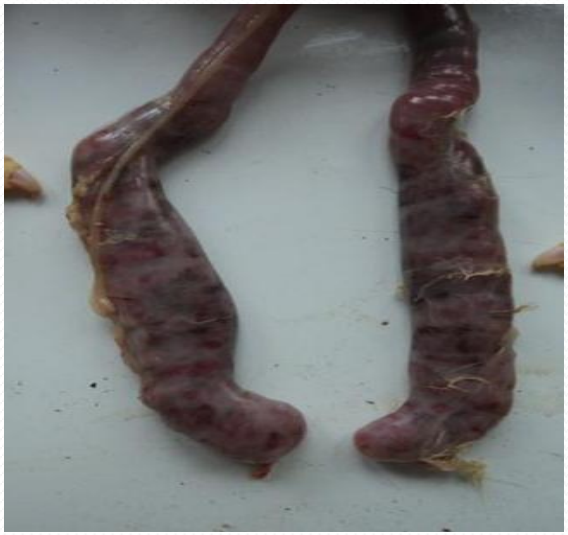
Aim of presentation

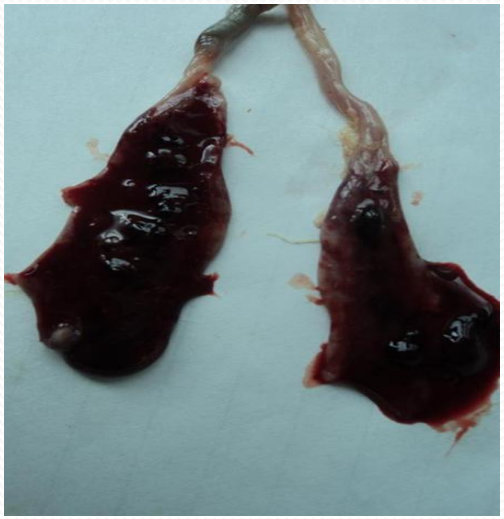
- to highlight the extent of pathology and economic losses caused by coccidiosis .
- to review the current progress in our understanding of the host immune response to *Eimeria* .
- to discuss potential strategies which are currently being developed for coccidiosis control.

Life cycle of *Eimeria* (Courtesy Wikepedia)



Gross Pathology (Eimeria tenella)





Histopathology of cecum (*E. tenella*)

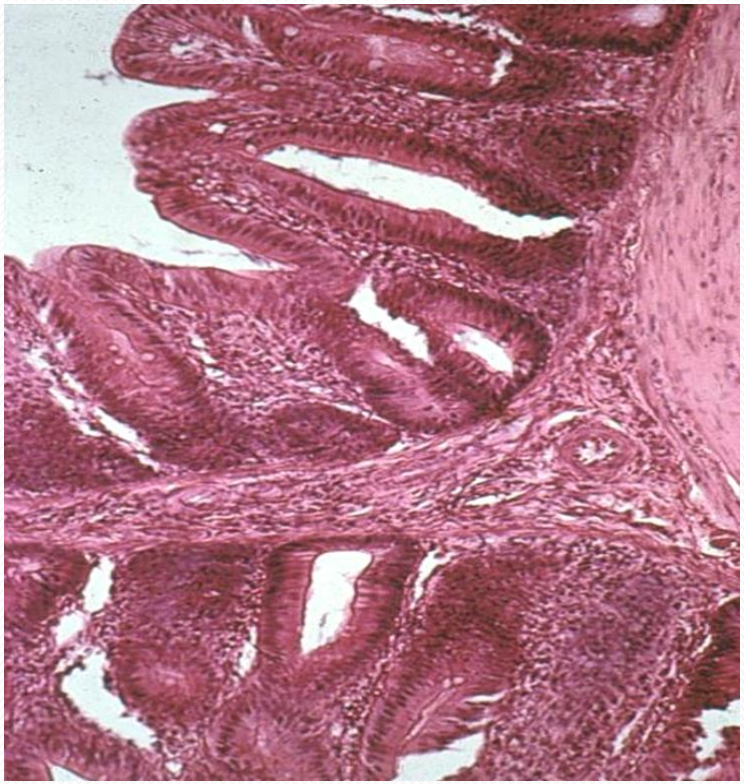


Figure : Uninfected Cecum

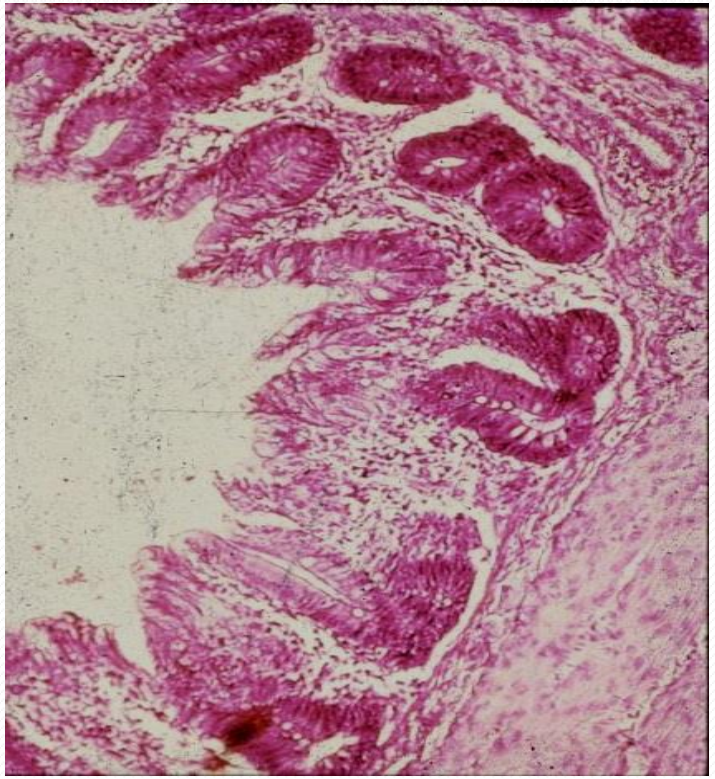


Figure : Cecum infected with *Eimeria tenella*

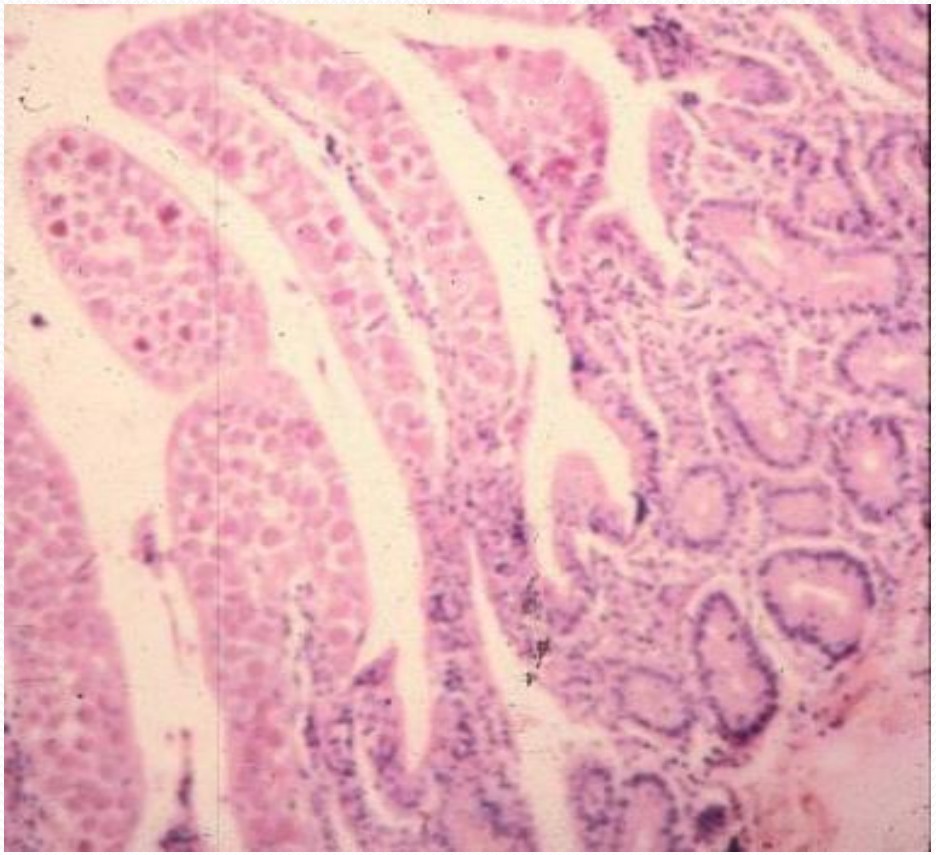


Figure: Endogenous phase of *Eimeria* in fowl gut

Immune Response to *Eimeria*

- *Eimeria* elicit both nonspecific and specific immune responses which involve many facets of cellular and humoral immunity (Lillehoj, 1991; Lillehoj 1998; Lillehoj and Lillehoj, 2000; Dalloul and Lillehoj, 2005)
- **Non specific Immune response**:
  - Physical barriers
  - Phagocytes
  - Leukocytes
  - Chemokines
  - Complement components
- **Specific Immune Response:**
  - Humoral immune response
  - Cell mediated immune response

Humoral Immune Response

- Following coccidiosis, both circulating and secretory antibodies specific for coccidia parasites are detected in serum, bile and intestine (Lillehoj and Ruff, 1987; Lillehoj, 1988; Yun et al., 2000).
- Three isotypes of antibodies are recognized in birds, IgM, IgA, and IgY (orthologue of the mammalian IgG (Leslie at al., 1969). The presence of other antibody classes such as IgD or IgE in chickens has not yet been documented.
- Maternal IgY is concentrated in the yolk sac of the egg (Rose et al., 1974) where it is transported to the embryo during late development by a mechanism similar to that found in mammals (West el al., 2004), and is thus considered to be of some relevance in maternal passive immunity (Wallach et al., 1992).
- Hens hyperimmunized with gametocyte surface antigens of *E. maxima*, passively transferred antibodies in young birds protected against challenge with sporulated *E. maxima* oocysts by reducing fecal oocyst production (Wallach et al., 1992).

Limited Role of Humoral Immune Response:

- Chickens Bursectomized by hormonal and chemical means were resistant to reinfection with coccidia (Rose and Long, 1970; Lillehoj, 1987)

- No correlation seen between antibody titres in serum and intestine with the level of protection after oral infection with coccidia (Dalloul et al., 20003; Lillehoj and Ruff, 1987

- However, Antibodies generated against specific epitope of coccidian parasites have been shown to be beneficial against coccidiosis infection (Walach et al., 1992; Ngyen et al., 2003).

Cell Mediated Immune Response

- Impairment of host protective immunity against coccidiosis on abrogation of T cell function by thymectomy (Rose and Long, 1970), cyclosporin A (Lillehoj, 1987), betamethasone, dexamethasone (Isobe and Lillehoj, 1993), and cell depletion using mouse monoclonal antibodies against CD8+ or abTCR-expressing cells (Trout and Lillehoj, 1996).
- Lillehoj and Choi (1998) and Miller et al. (1994), using an in vitro culture, showed that splenocytes from *E. tenella*-immune chickens inhibited the intracellular development of *E. tenella* in kidney cells. The nature of these cells was not determined, but may be NK cells since they did not show any MHC restriction in their action.
- **Role of gd T cells:**
  - In the gut, intraepithelial lymphocytes (IEL) having predominant gd T cells, represent an important component of the Gut Associated Lymphoid Tissue (GALT) (Guy-Grand et al., 1974).

- Following primary and secondary infections with *E. acervulina*, an increased percentage of intraepithelial gd T cells was observed in the duodenum (Choi and Lillehoj, 2000).

Role of CD8+ Tcells:

- In avian coccidiosis, the selective elimination of CD8+ cells by anti-CD8+ monoclonal antibody resulted in exacerbation of the disease, as evidenced by increased oocyst shedding after infection with *E. tenella* or *E. acervulina* (Trout and Lillehoj, 1996).
- Significant increase of T cells expressing CD8+ molecules was noted in the intestinal IEL population following challenge infections of chicken with *E. acervulina* (Lillehoj and Bacon, 1991).

Challenges

- While natural infection with *Eimeria* spp. induces immunity, vaccination procedures on a commercial scale have shown limited effectiveness (Dalloul and Lillehoj, 2005).
- live parasite vaccines are labor-intensive production and high cost due to inclusion of multiple parasite species in the vaccine but live oocyst vaccines represent a limited but useful alternative to anticoccidial drugs.
- Recombinant vaccine composed of parasite antigens/antigen-encoding genes that elicit coccidia-specific immunity would be eminently preferable but the difficulty remains to identify the antigens or genes which are responsible for eliciting protective immunity and to devise the most efficient delivery method for these recombinant vaccines to be delivered and presented to the bird's immune system.

- Main obstacle to the development of an antibody-based strategy against avian coccidiosis is the existence of many different *Eimeria* species.

- Recent studies have provided much evidence that molecular and immunological-based strategies such as recombinant vaccines and dietary immunomodulation enhance gut immunity. Thus, successful application of new knowledge on host-parasite immunobiology, gut immunity and genomics in commercial settings will lead to the development of novel disease prevention strategies against coccidiosis in the near future

- **Vaccines available:**
  - vaccines based on live virulent strains
  - vaccines based on live attenuated strains
  - vaccines based on live strains that are relatively tolerant to the ionophore compounds.

- **Future Vaccines:** in the near future more varieties of oocyst based live vaccines are expected, identification of selective coccidian-specific immunoprotective molecules is likely to get more attention to facilitate the sustainable control of poultry coccidiosis.

THANK YOU