



# Diseases in Cage-free Systems

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# What makes the pathology in cage-free birds different?



Fecal-oral infection is possible



Some behaviors are not mitigated



Low biosecurity on external parks



Flock management is more complicated

# Most important health problems in US

## Caged laying hens

Rank	Disease	Score
1 tie	E coli	2.63
1 tie	Infectious bronchitis	2.63
3	Infectious coryza	2.37
4 tie	FDN	2.16
4 tie	ILT	2.16
4 tie	Calcium Depletion	2.16
7	Coccidiosis	1.89
8 tie	Cannibalism	1.79
8 tie	NFM	1.79
8 tie	Necrotic enteritis	1.79

## Cage-free laying hens

Rank	Disease	Score
1	E coli	3.28
2 tie	Infectious bronchitis	2.78
2 tie	<b>Roundworms</b>	2.78
4 tie	<b>Piling</b>	2.72
4 tie	Cannibalism	2.72
6	<b>Coccidiosis</b>	2.33
7	ILT	2.28
8	Infectious coryza	2.17
9	Necrotic enteritis	2.00
10 tie	FDN / FC / EDS	1.89

Source: AVEP  
2022 Disease  
Survey

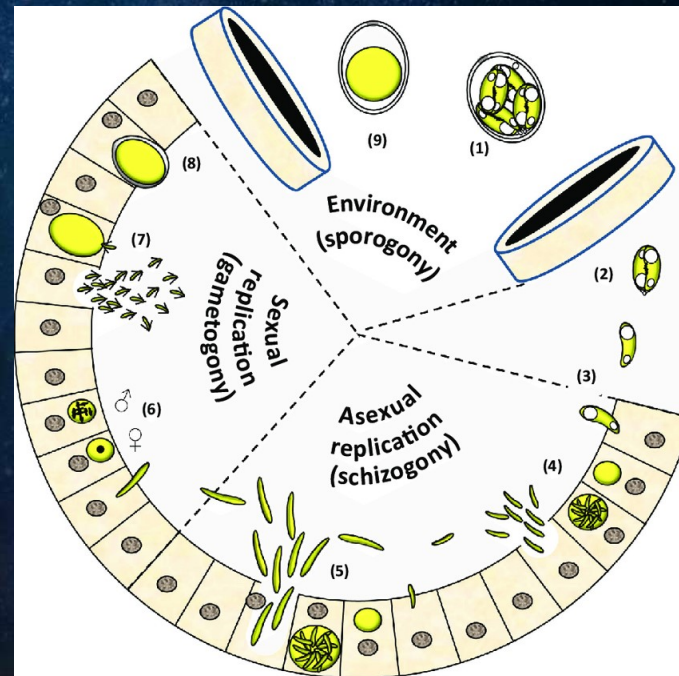


# Coccidiosis

# Coccidiosis

Etiologic agent: **Eimeria Spp.**

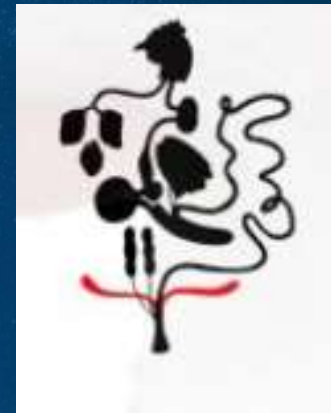
- It is a protozoan with a cycle in the poultry gut and in the environment.
- Different species produce different lesions in the gut.
- It is found worldwide.
- There is no cross-protection between species



Picture:  
Finley 2013

# Coccidiosis

## Eimeria Tenella



Source: ANSES

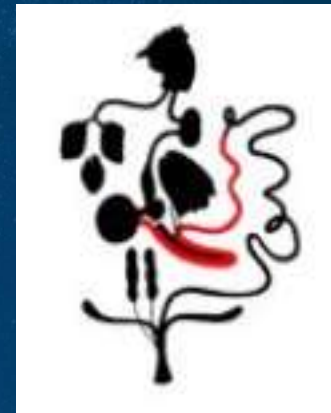
# Coccidiosis

## Eimeria maxima



# Coccidiosis

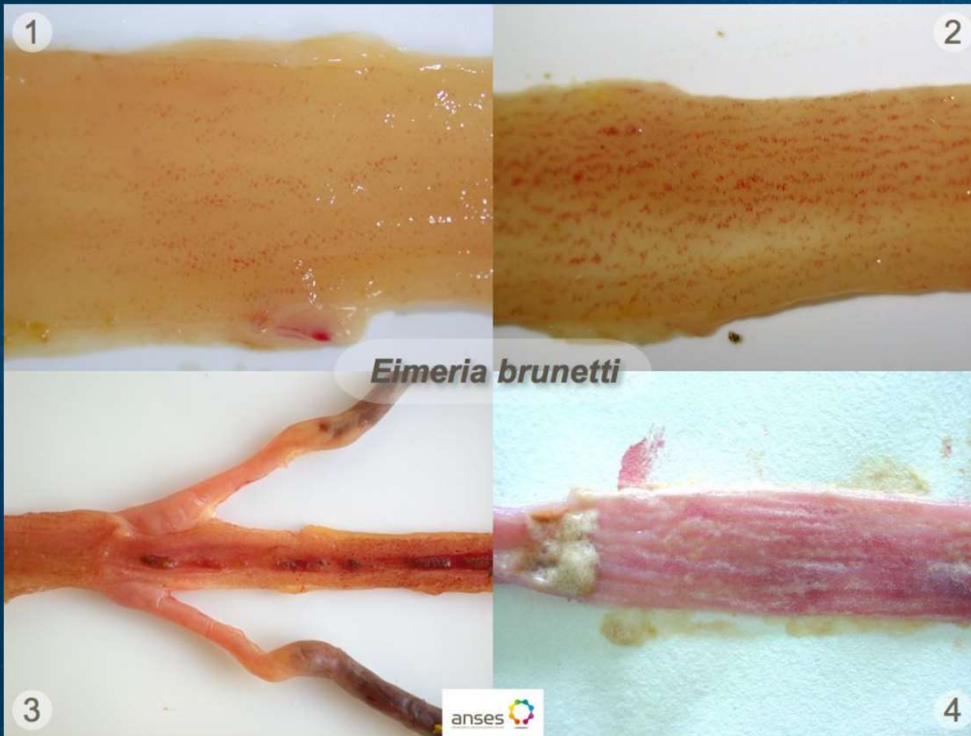
*Eimeria Acervulina*



Source: ANSES

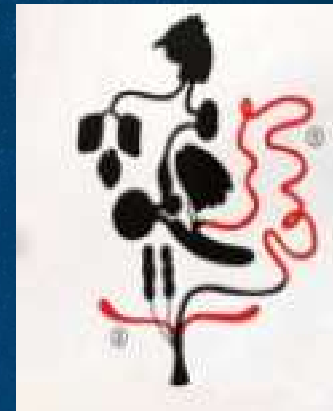
# Coccidiosis

## Eimeria Brunetti



# Coccidiosis

*Eimeria necatrix*

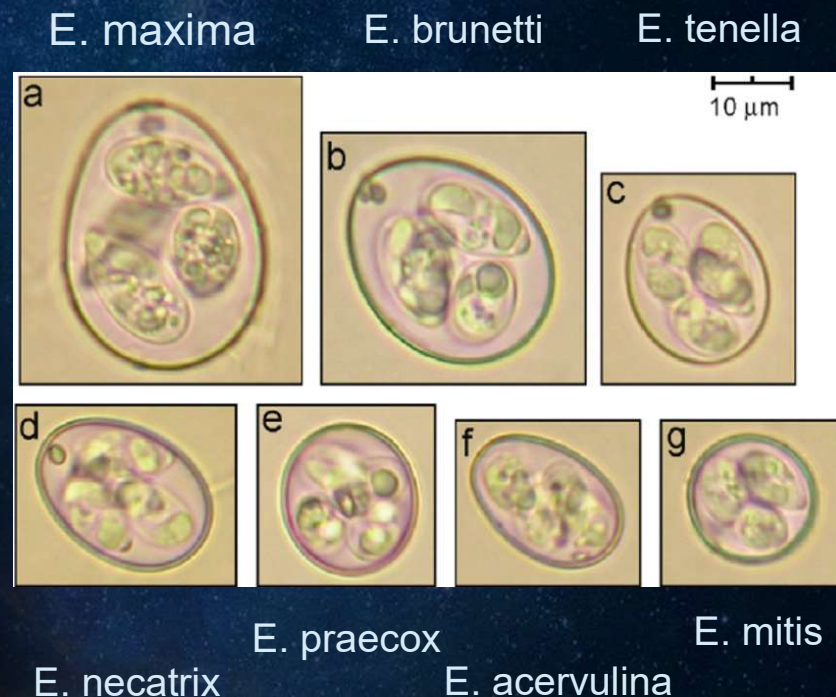


Source: ANSES

# Coccidiosis

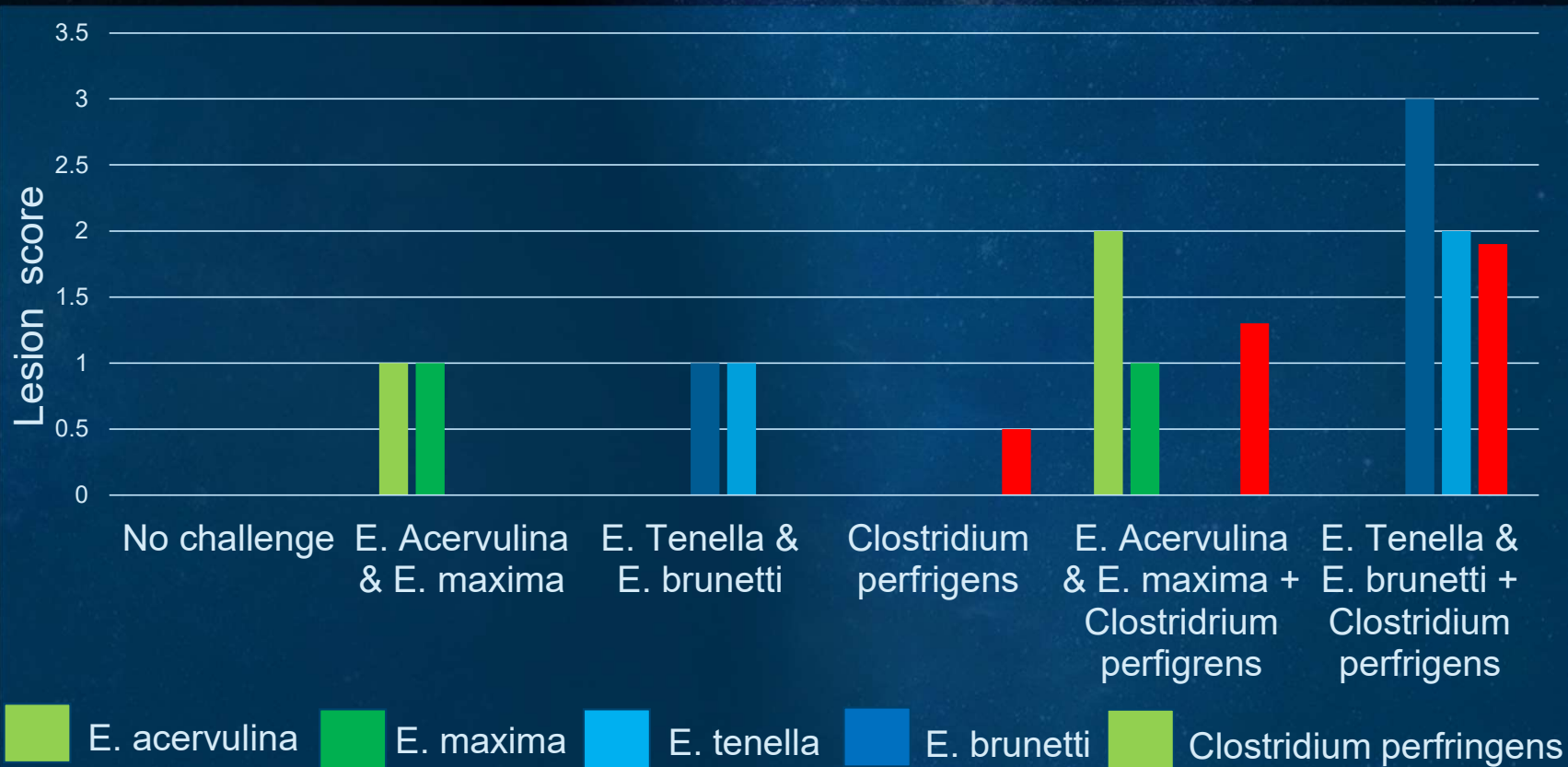
Infectious form: **oocyst**

- Very resistant to the environment
- Heavy and large in size
- Must sporulate to become infectious in a humid and warm environment
- Different species vary in size and morphology



# Coccidiosis

## Gut health & Coccidia



Source:  
Alnassan 2014

# Coccidiosis

## Health program objective



### Short life birds

No delayed growth  
No anticocci resistance



#### 1. Anticocci program

Rotation program

Shuttle program

Bio-shuttle program

#### 2. Vaccine programs

#### 3. Phyto programs



### Long life birds

Long lasting immunity  
against the different  
Eimeria species



#### 1. Vaccines program

+ Anticocci

+ Phyto

#### 2. ~~Anticocci programs~~

Challenge required !!!

# Coccidiosis

## Vaccine by type of bird



### Short life birds vaccines

Eimeria acervulina  
Eimeria maxima  
Eimeria Tenella  
Eimeria Mitis  
...



### Long life birds vaccines

Eimeria acervulina  
Eimeria maxima  
Eimeria tenella  
Eimeria mitis  
Eimeria brunetti  
Eimeria praecox  
Eimeria Necratix

# Coccidiosis

## Vaccine by strain attenuation

### Natural strains

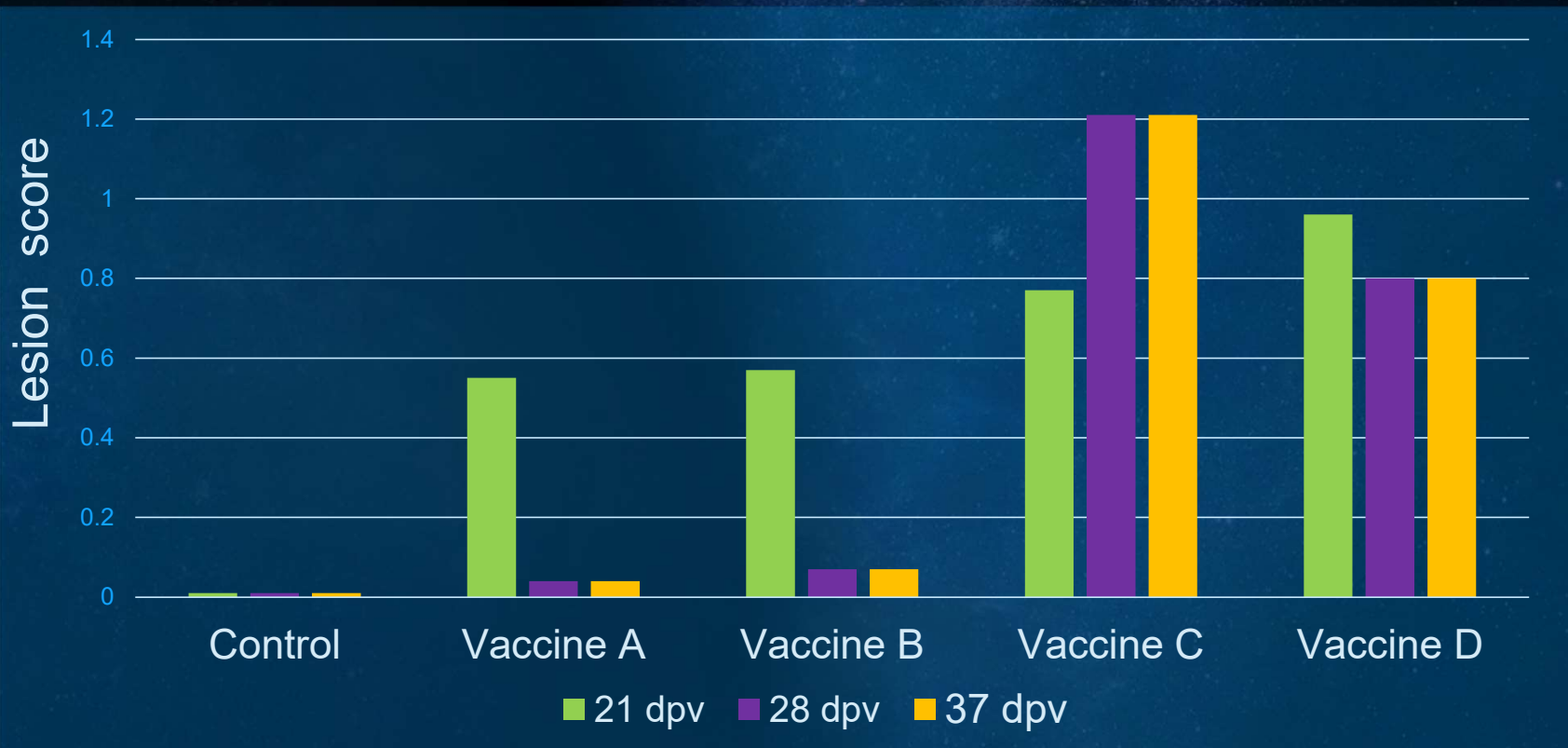
- +
  - Low cost
  - Excellent dissemination in the barn
- - Still pathogenic strains: mitigation may be required
  - Introduction of pathogenic strains into the house

### Attenuated strains

- +
  - Less lesions produced during the Eimeria cycle
  - Non pathogenic strains
- - High cost
  - Poor dissemination in the barn

# Coccidiosis

## Attenuated vaccines VS Natutal vaccines



Source:  
M. Dardi

# Coccidiosis

## Spray vaccine process



Vaccine preparation



Coarse Spray



Droplet ingestion



Vaccine strain recirculation

# Coccidiosis

## Vaccine administration methods



~~Spray in feed~~



Spray chick boxes  
at farm



~~Drinking water  
(Nipples)~~



Spray chick boxes  
at hatchery

# Coccidiosis

Coarse spray: The size ( and the weight) matters



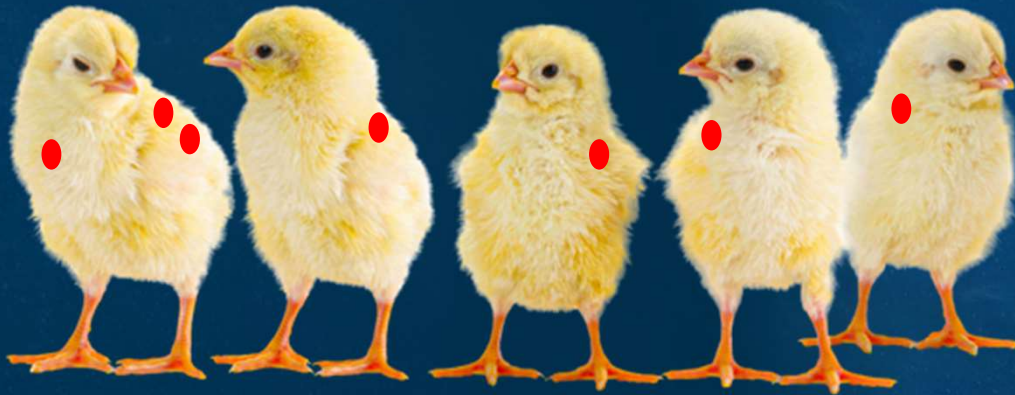
# Coccidiosis

Droplet ingestion: using the curiosity to our advantage

What is this red thing in your neck?

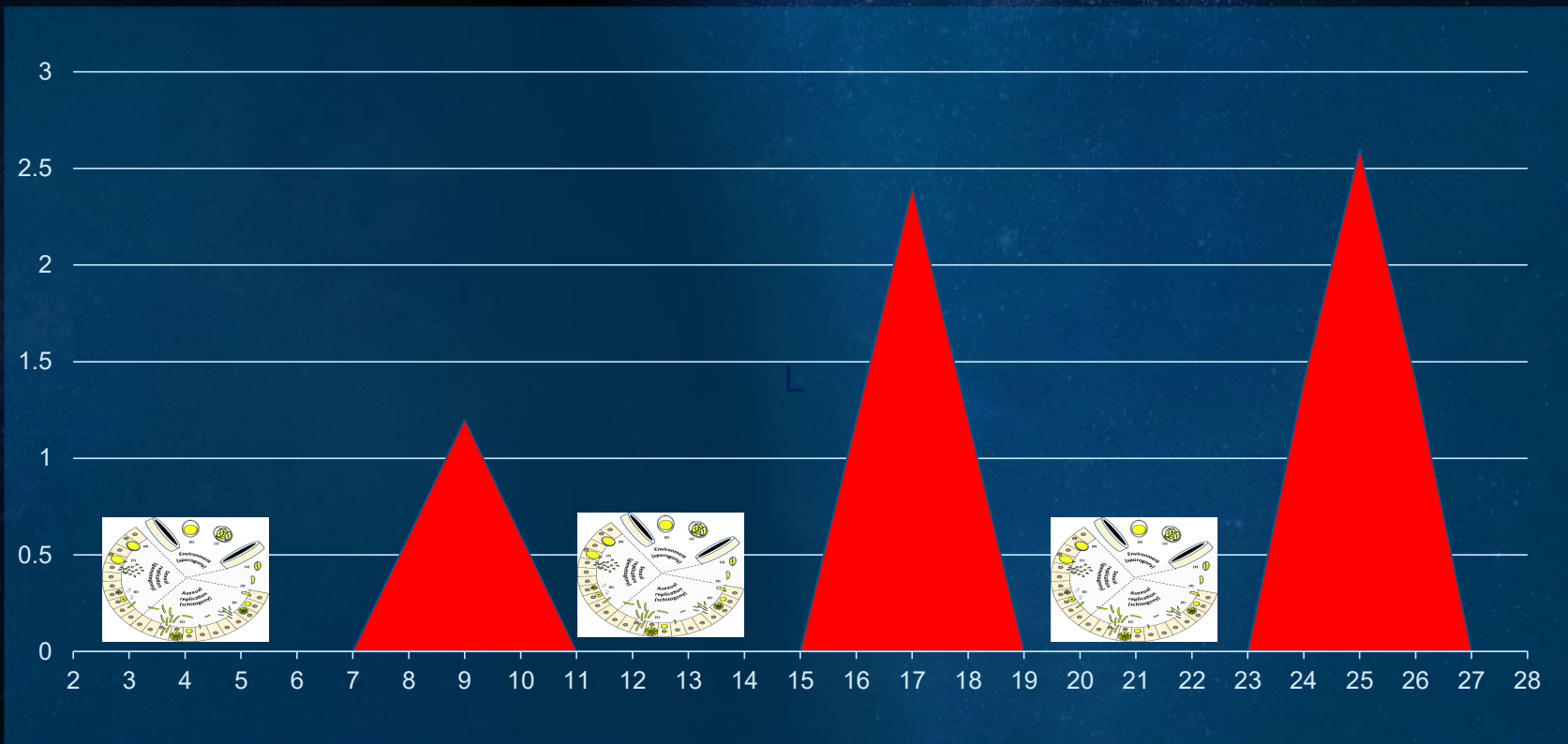
Whoaaa, red things !!!

“Yummies” droplets  
Curious chicks  
Light  
Time  
Temperature



# Coccidiosis

## Vaccine recirculation



# Coccidiosis

## Vaccine recirculation

### Natural strains

- + { Easy vaccine dissemination
- { Mitigate strains pathogenicity
  - Give more room ASAP
  - Control litter humidity
  - LAST RESOURCE: Anticocci treatment

### Attenuated strains

- + { Low pathogenicity
- { Facilitate strain dissemination
  - Give more room while respecting the Eimeria cycles.
  - When giving more room, move litter with the chicks
  - Assure correct litter humidity

# Coccidiosis

## Main types of litter

### Wheat straw



WHC: 290%

### Wood shaving



WHC: 141%

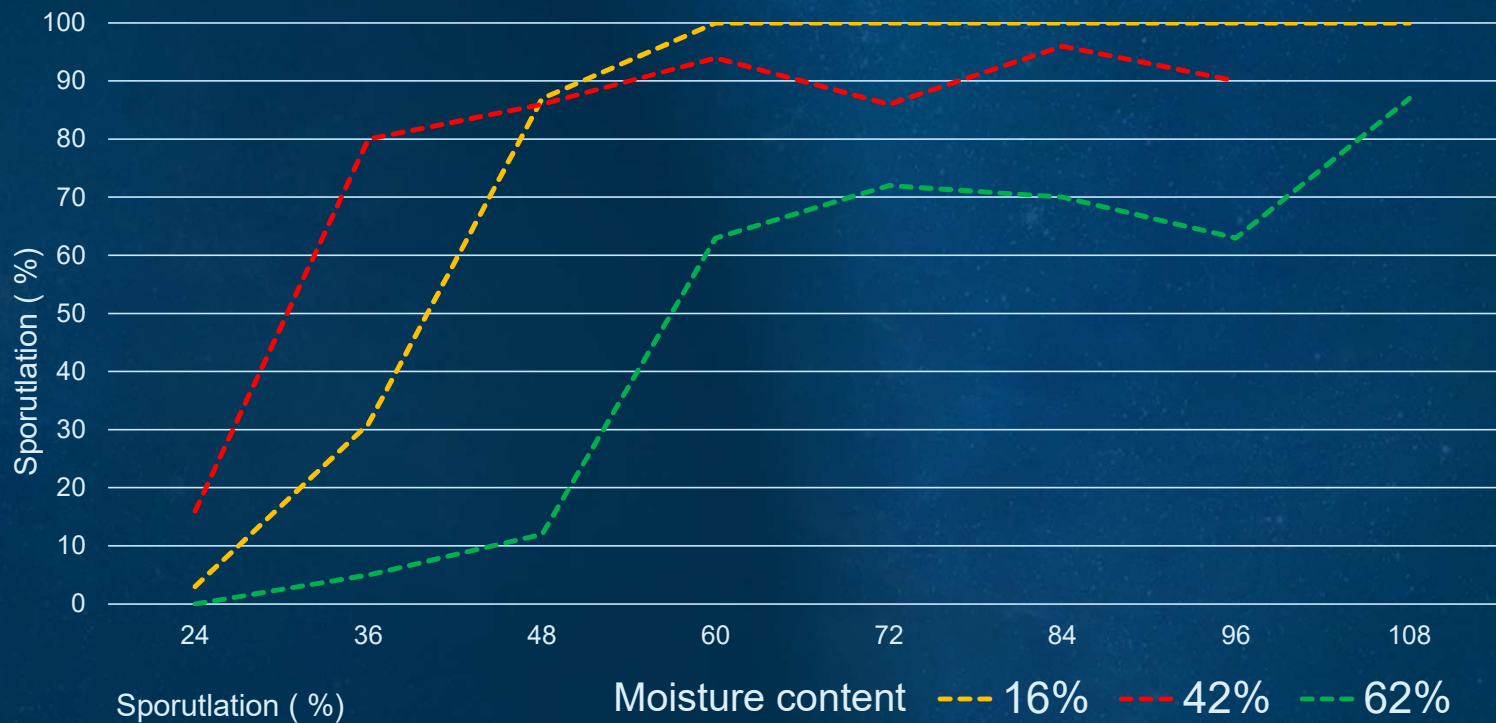
### Rice hull



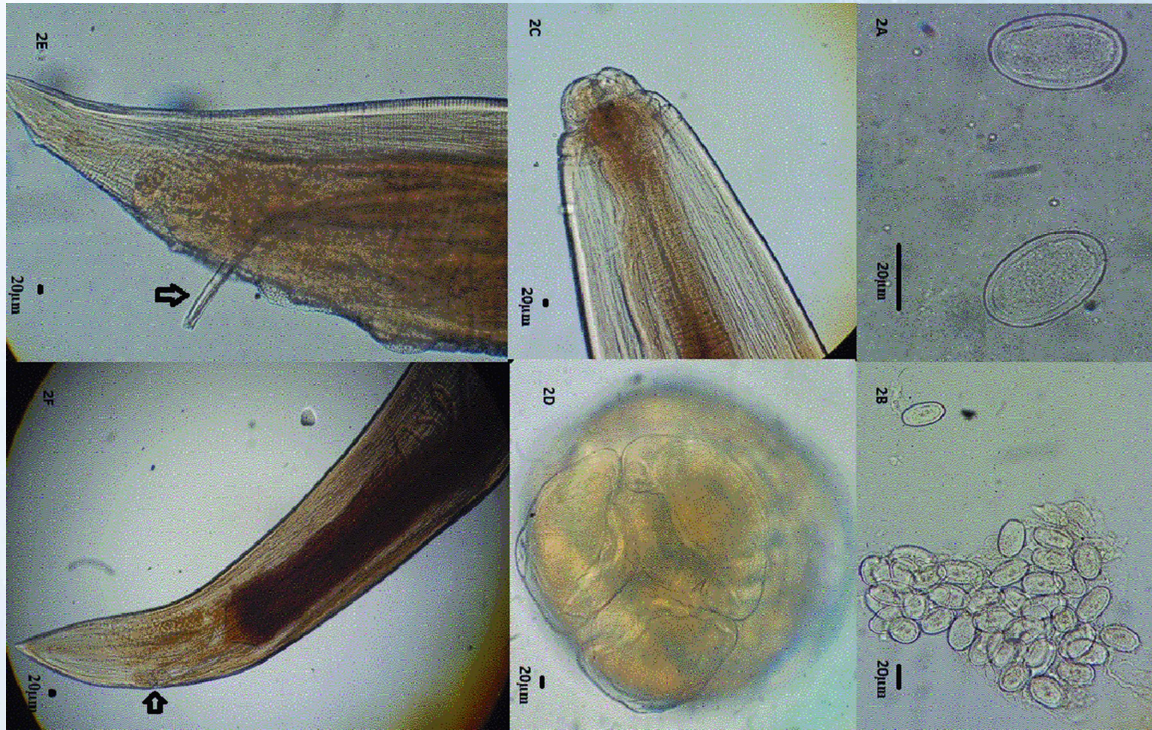
WHC: 116%

# Coccidiosis

## Litter humidity & oocyst



Source:  
Waldenstedt 2001



# Helminths

# Helminths

What are we talking about?



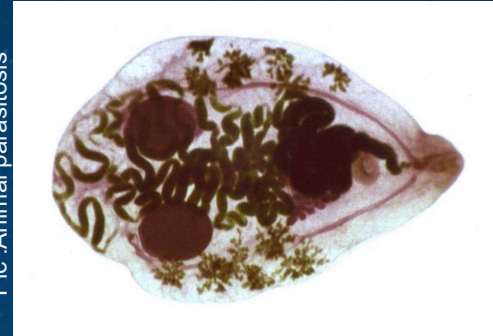
**Nematodes**  
Round worms

Pic.:Poultry site



**Cestodes**  
Tape worms

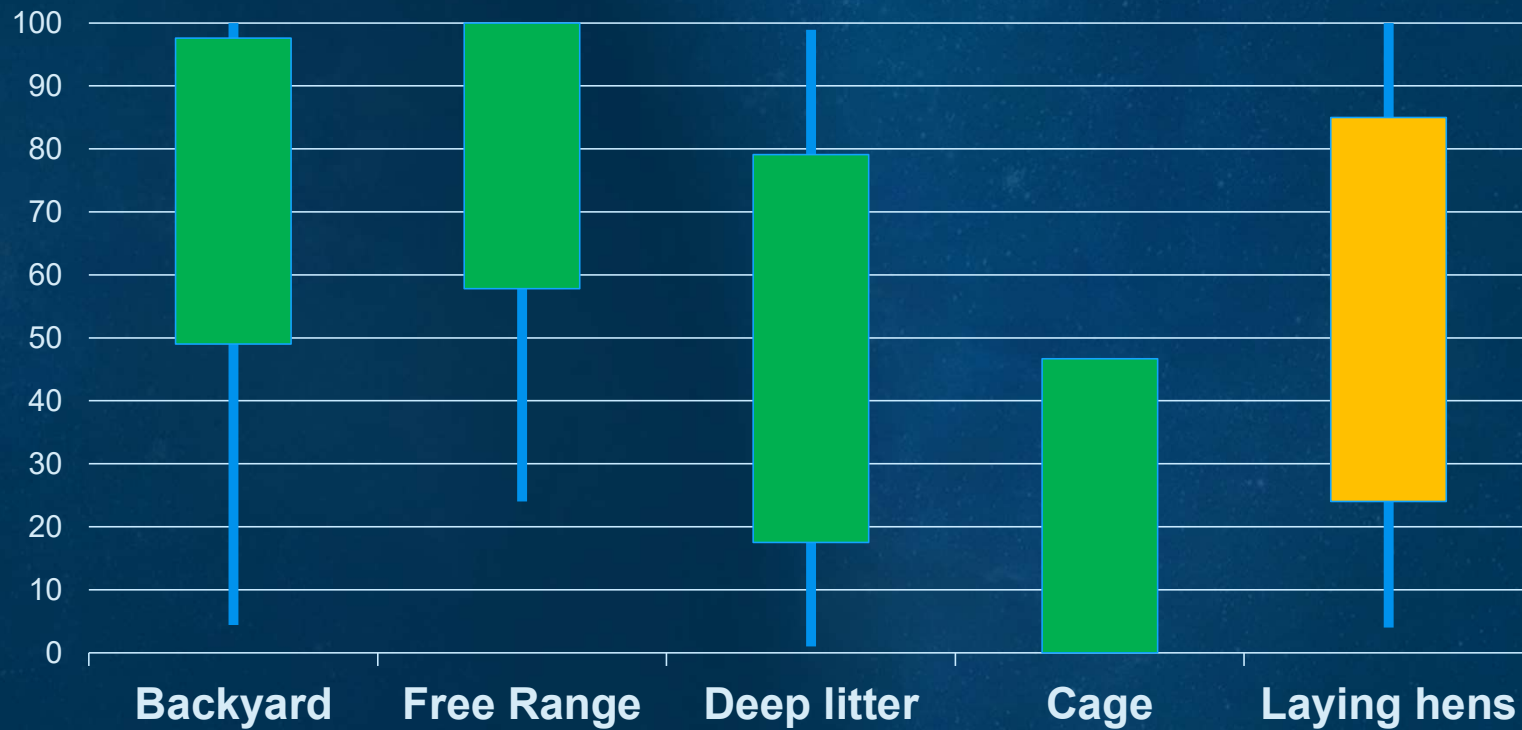
Pic.:Animal parasitosis



**Trematodes**  
Flukes

# Helminths

## Prevalence by production type – Systematic review

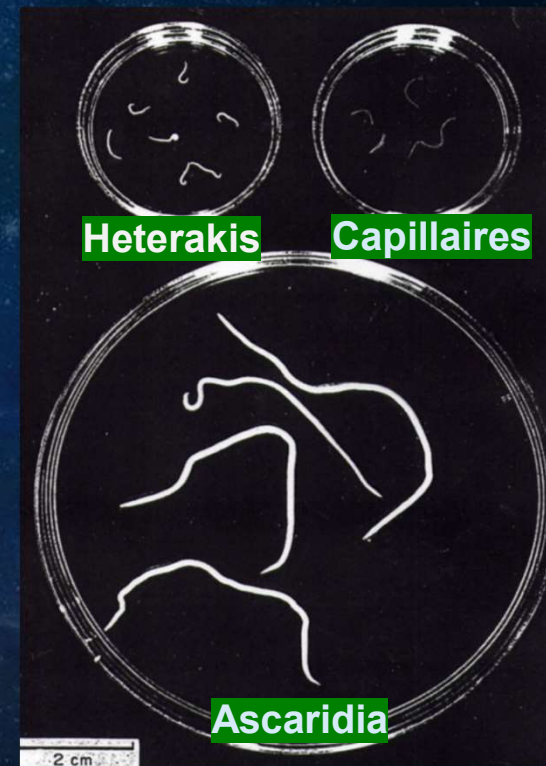


Source:  
Shifaw 2021

# Helminths

## Nematodes ( Round worms)

- Ascaris
  - Ascaridia sp.
  - Heterakis sp.
- Capillaires
  - Capillaria sp.
- Spirures
- Strongles
  - Trichostrongylus tenuis



Picture:  
Reussir.fr

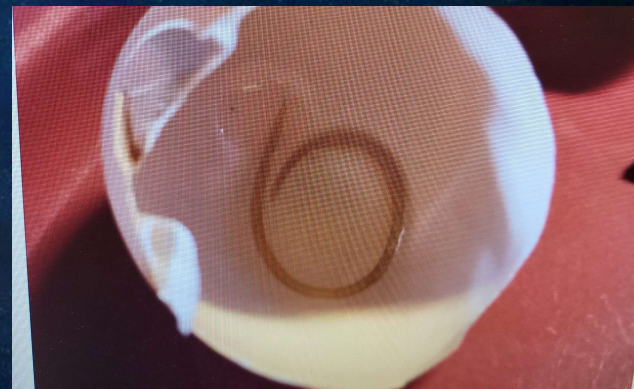
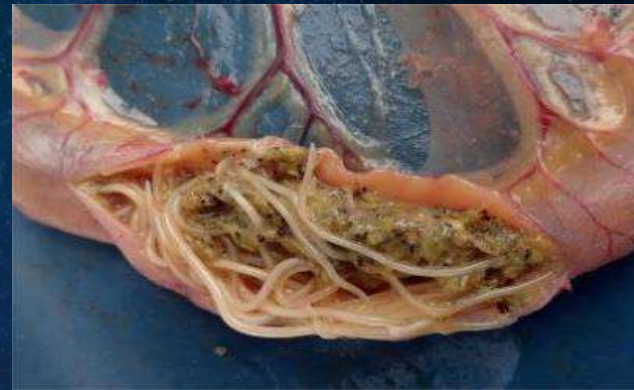
# Ascaris

## Ascaridia

### Etiologic agent:

Ascaridia Galli.

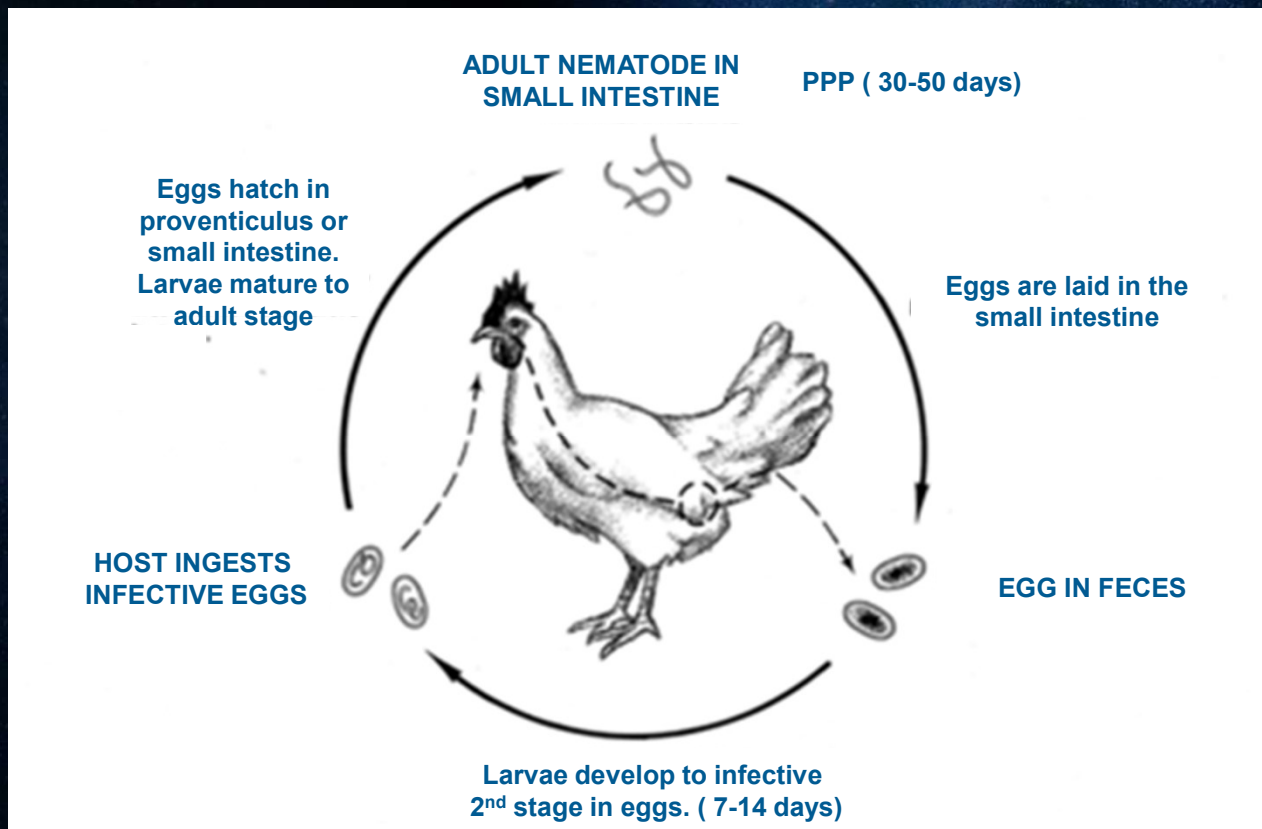
- Nematodes. It can measure 6 - 11cm as adult and infest the intestine
- Egg drop and bodyweight losses is possible in case of strong infestation
- No report of infestation in humans



Pictures:  
Wattagen

# Ascaris

## Life cycle



# Ascaris

## Clinical sign

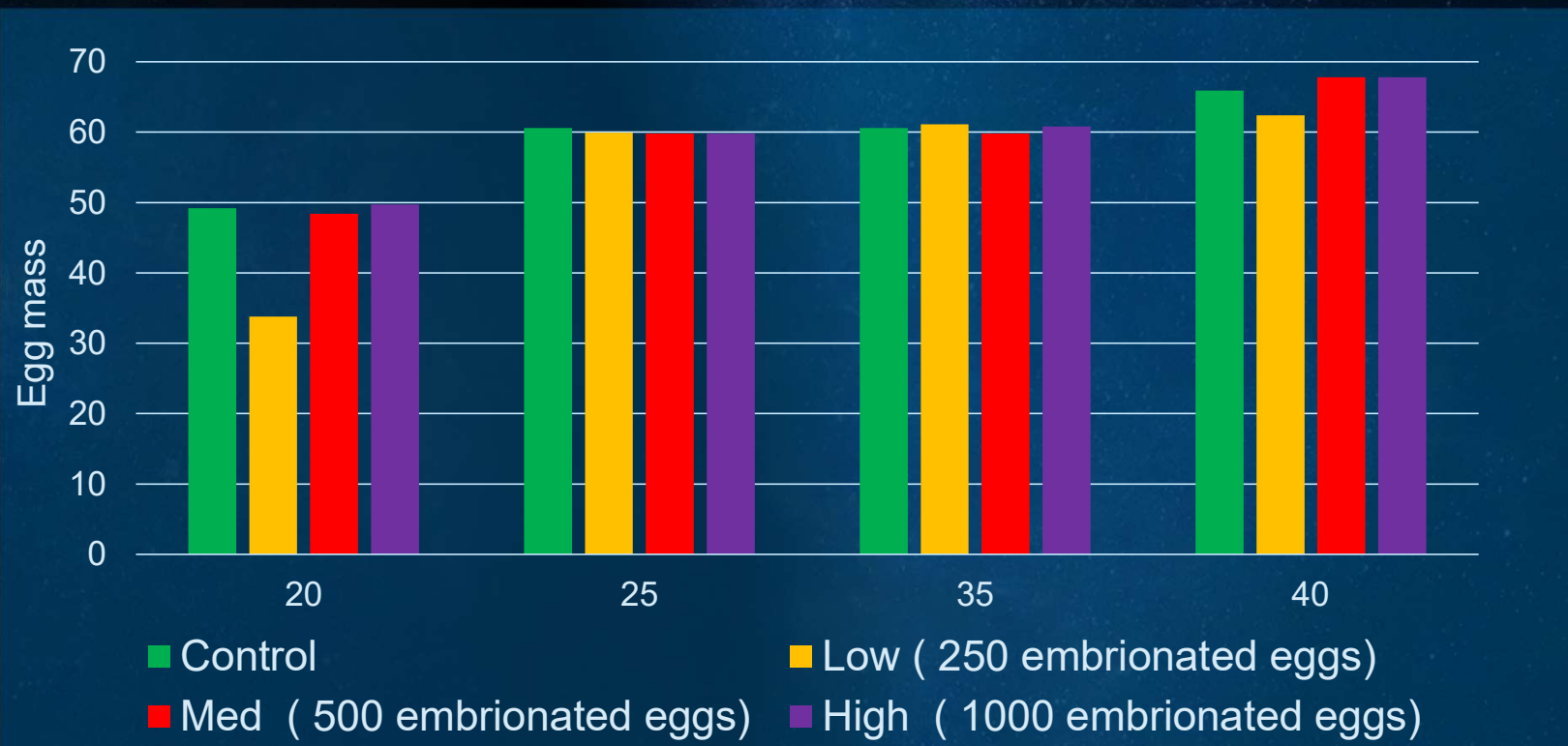
Anorexia  
Loss of body weight  
Ruffled feathers  
Drooped wings  
Retarded growth,  
Altered hormone levels  
Depression  
Increased cannibalism

Not bad  
for a  
worm!!



# Ascaridia

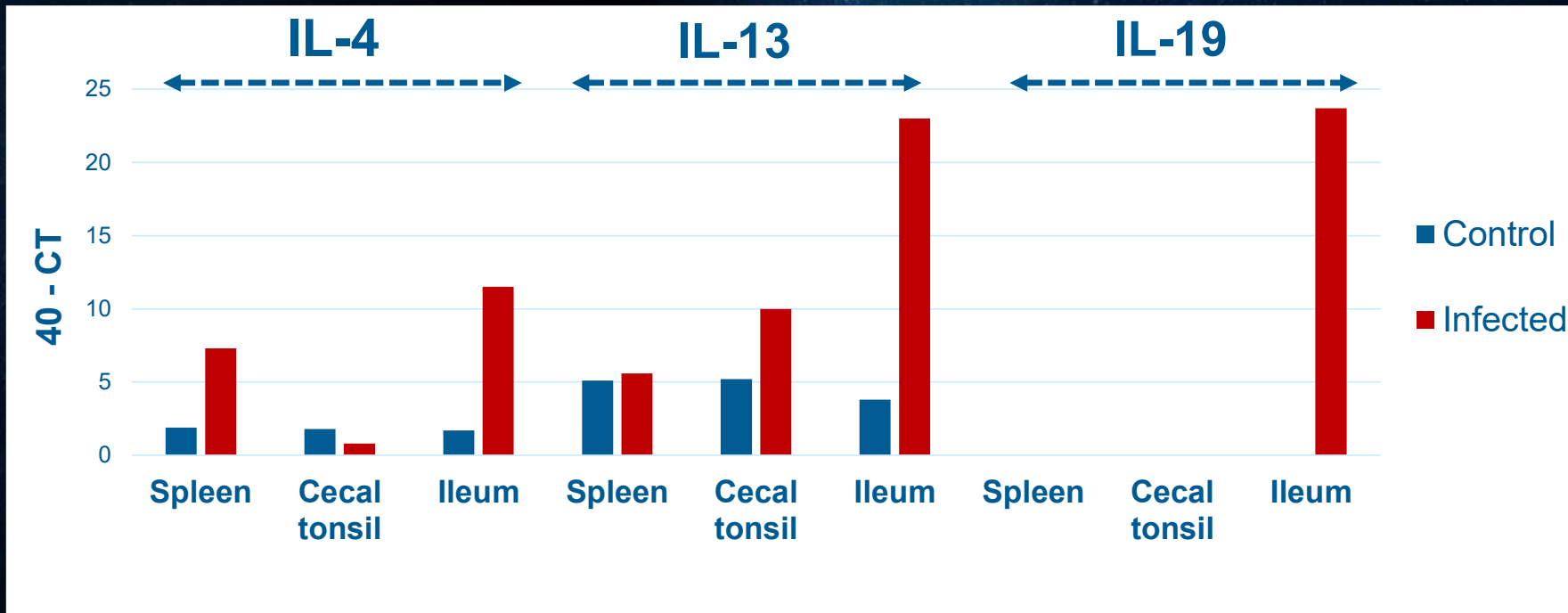
Effect of different infestation levels of *Ascaridia galli* on egg mass.



Source:  
Sharma 2017

# The Immune Response

Expression of mRNA for Th2 cytokines following oral infection with 1000 *Ascaris galli* worm eggs



Source:  
Degen 2004

# Heterakis

## Heterakis

### Etiologic agent:

*Heterakis gallinarum*

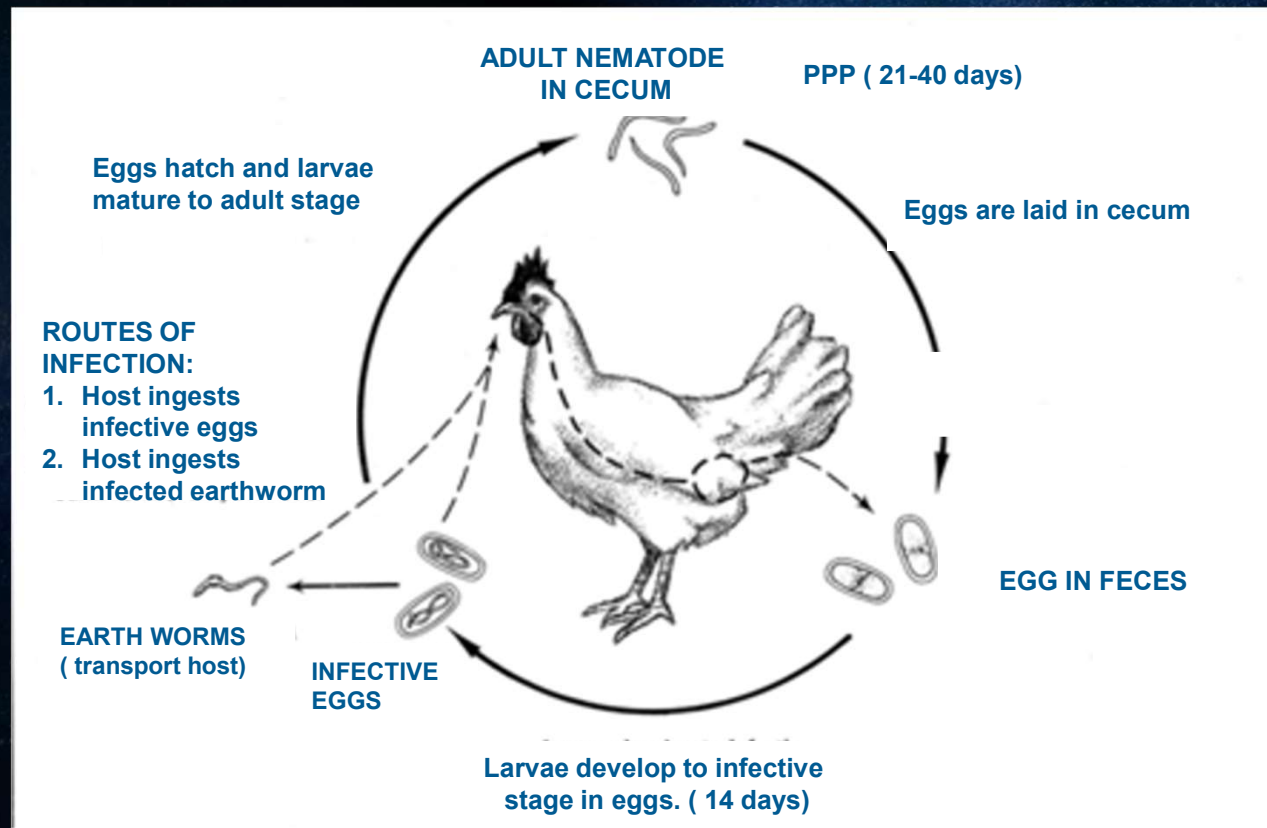
- Nematode. It can measure 1-1,5 cm and infest ceca.
- It can produce ceca inflammation
- It can be hosted by earth worms
- It can host *Histomona meleagridis*



Pictures:  
Wattagen

# Heterakis

## Life cycle



# ( Beyond) Heterakis

## Histomonosis

### Etiologic agent:

*Histomonas meleagridis*.

- Flagellated amoeboid Protozoan
- Sulfur-colored droppings, characteristic lesion in ceca and liver
- High mortality ( 30%) can occur in chickens
- Very complicated treatment because the lack of authorized drugs



Pictures:  
Wattagen

# Ascaris

## Health program

### Prevention

Biosecurity

( Free range???)

### Eradication

Not possible

### Control

#### Monitoring

Ascaris finding in autopsies

Egg in faecal droppings

#### Treatment

Benzimidazoles (fenbendazole  
and flubendazole)

Imidazothiazoles (levamisole  
and pyrantel)

Macrocyclic lactones  
(ivermectin)

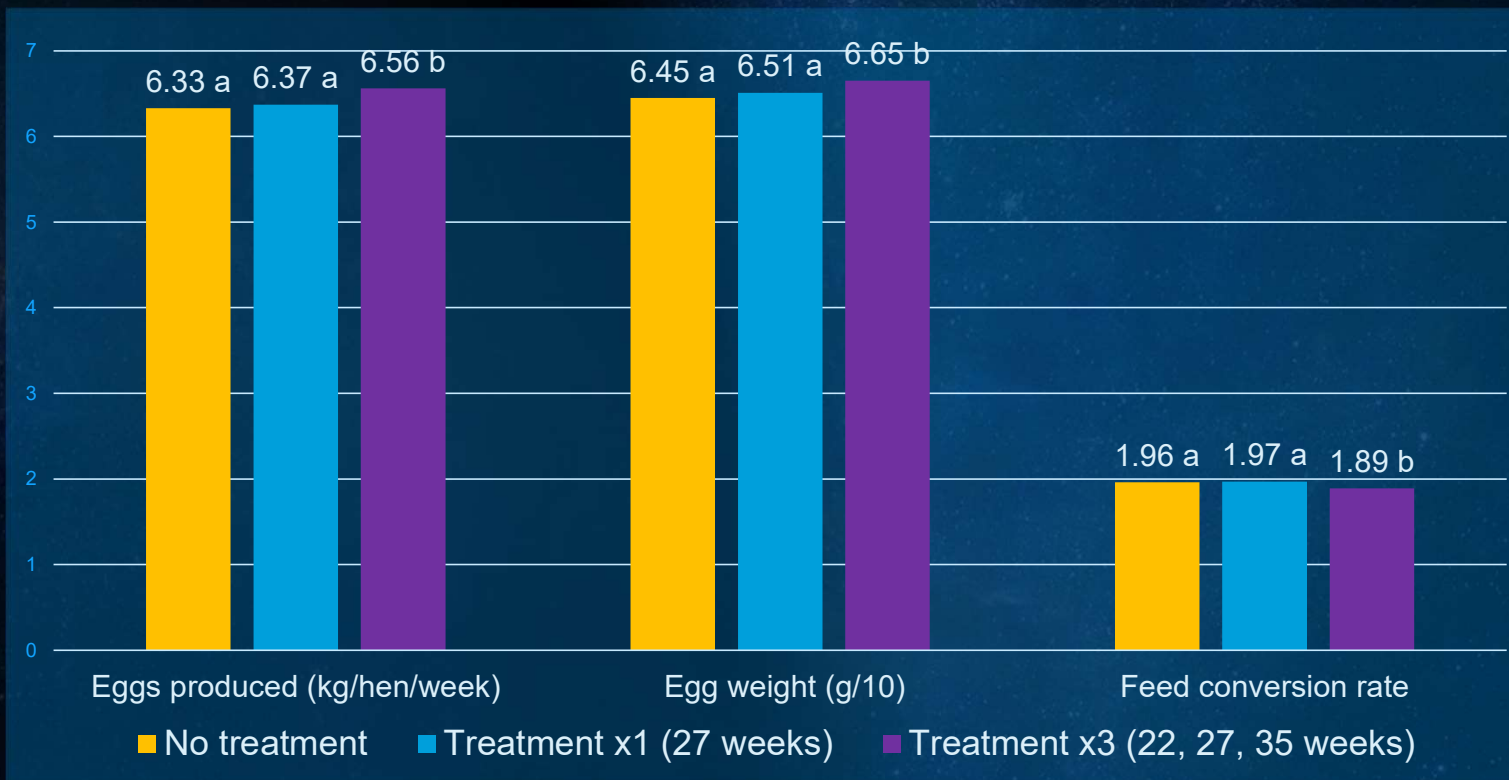
#### Passive control

Specific disinfection

Outdoor park rotation ?

# Ascaris

Cumulative production data between week 21 and 44 in three groups receiving three fenbendazole treatment models



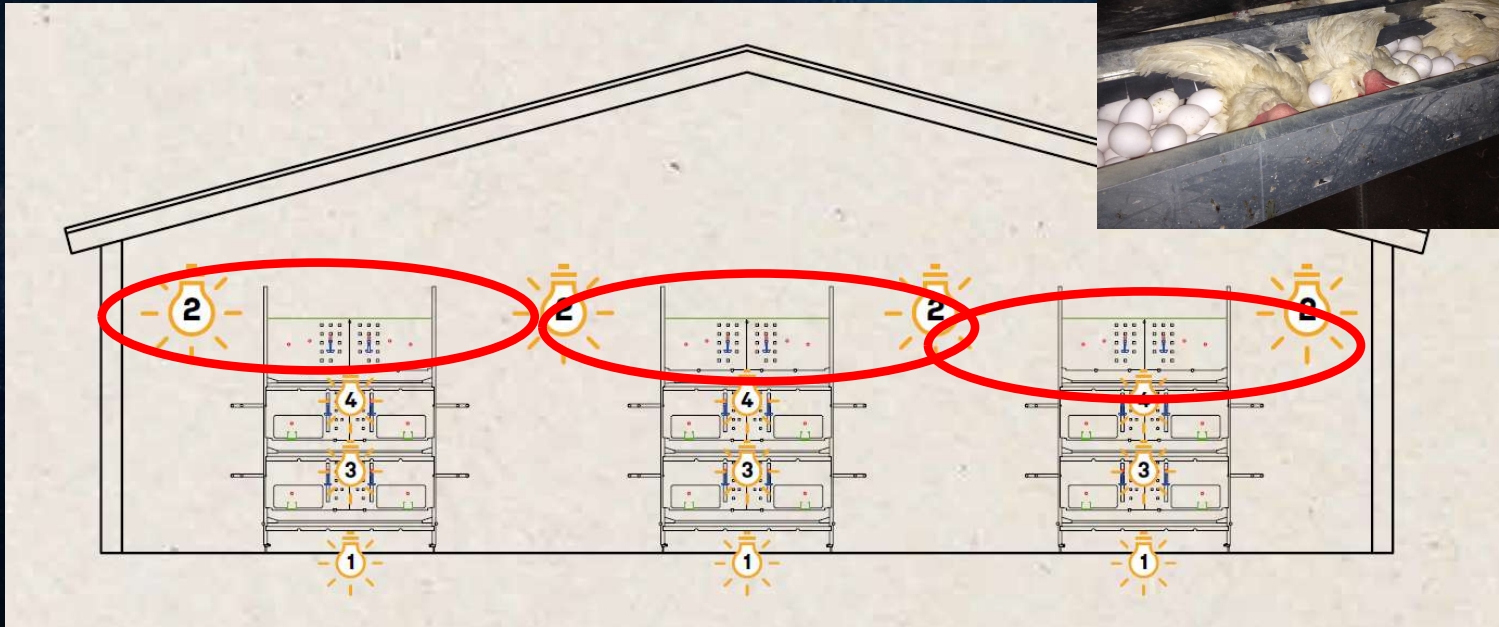
Pictures:  
Tarbiat 2019



**Piling**

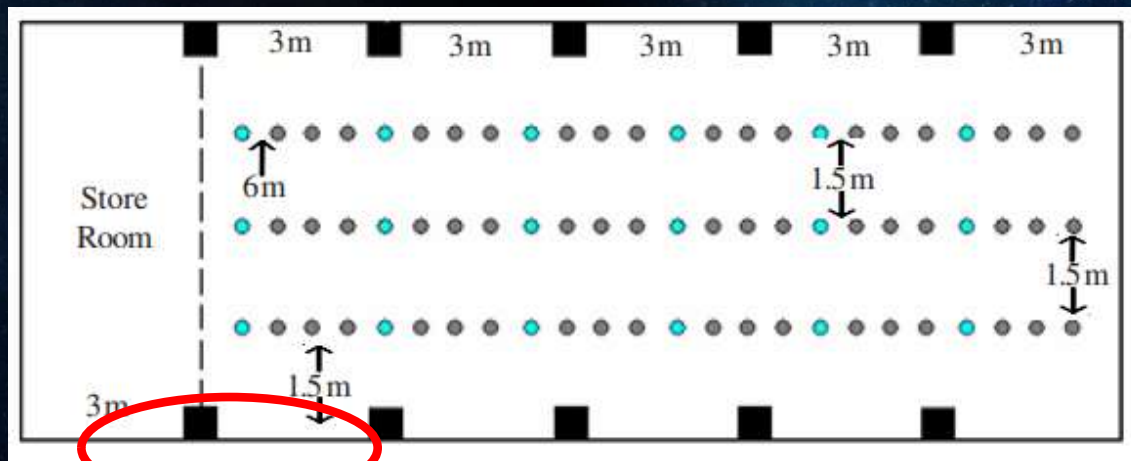
# Piling

## Nest Piling



# Piling

## Panic piling



Predation episode



Loud sounds



Disturbing visits

# Piling

## Reiterative piling

First pile-up event



Pile-up increase event



Piling event



Suffocation event



Source:  
Gray 2020



# Escherichia coli

# Escherichia coli



- Enterobacteriaceae (Gram-, bacillus)
- Routinely isolated from the gut microbiota flora of healthy hens
- Several potential virulence factors have been identified in APEC strains
  - Certain somatic serotypes (O1, O2, O78)
  - K80 Capsular Antigen
  - Presence of aerobactins

# Escherichia coli

Common inhabitant of the intestinal tract



Intestinal contents  
10<sup>5</sup> – 10<sup>6</sup> CFU  
per gram



Poultry house dust  
10<sup>5</sup> – 10<sup>6</sup> CFU  
per gram



Colon content  
10<sup>6</sup> – 10<sup>8</sup> UFC  
per gram

A percentage may be potentially pathogenic E. coli strains

# Escherichia coli typing



Serotyping



Molecular typing



Pathotyping

O (Somatic)  
H (Flagellar)  
K (Capsular)  
F (Pilus)

Only 20% of genes  
are common to all  
strains  
-> Virulence factor

APEC  
Avian Pathogenic E. coli

# Patogenesis

## Healthy birds are very resilient



### Primary pathogen

(young chickens and laying hens).



### Opportunistic pathogen

(broilers and laying hens)



### FAVORING FACTORS:

- Compromised skin or mucosal barriers
- Altered mononuclear-phagocytic system.
- Immunosuppression (IBD/Gumboro).
- Stress.

# Favoring factors



## VIRUS

- IBD
- CIAV
- MD
- IBV
- AmPV
- ILT
- ND
- AI



## BACTERIAS

- Pasteurella
- MG
- MS
- Avibacterium
- Gallibacterium



## PARASITES

- Ascaridia
- Eimeria
- Histomonas



## TOXICS

- Mycotoxins
- Ammonia
- Cyclofamide



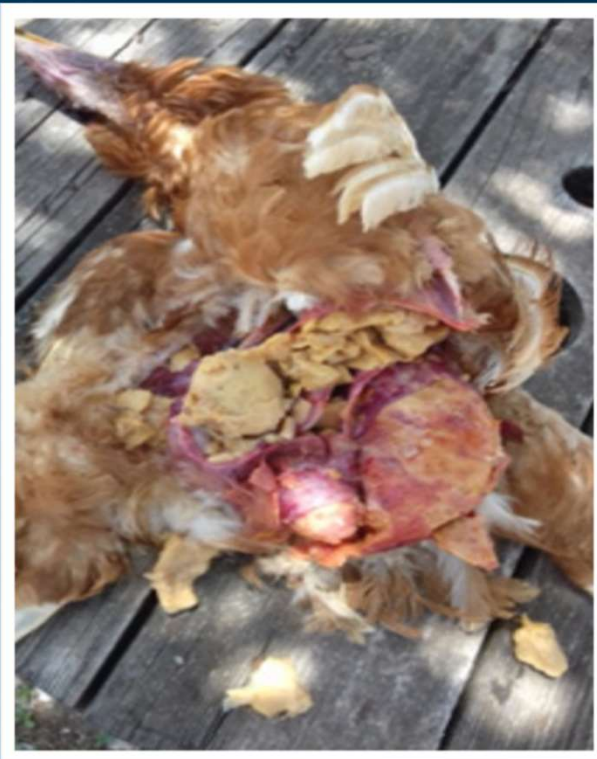
## ENVIRONMENTAL

- Contaminated water
- Dust, dryness
- Temperatures
- Inadequate ventilation
- Wet bedding
- High stocking density



# Clinical signs

## Localized forms



- Coliform omphalitis
- Coliform cellulitis
- Swollen head syndrome
- Diarrheal disease
- **Salpingitis/peritonitis**

# Salpingitis / Peritonitis



- Distended, thin-walled oviduct with exudate.
- Low-medium incidence (1.1% at 32 weeks). Wang et al., 2020
- Chronic.
- Spread of *E. coli* to the abdomen induces concurrent peritonitis (salpingoperitonitis).

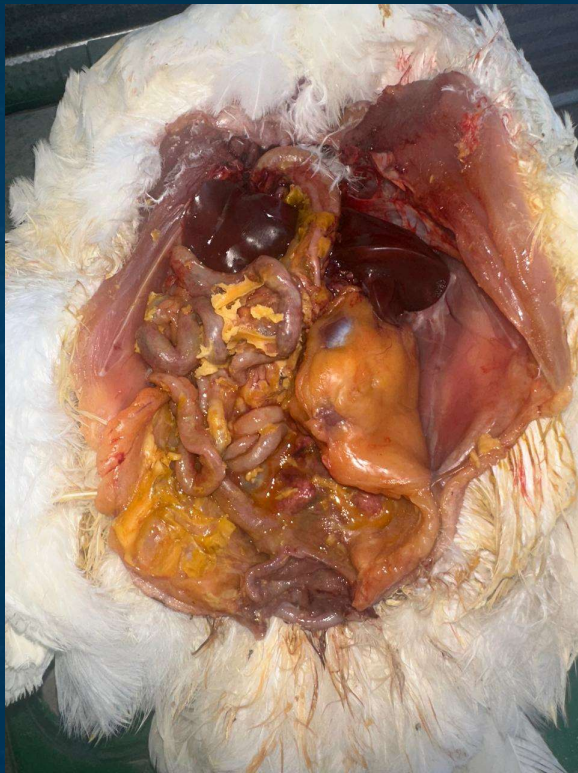
# Clinical Signs

## General forms



- Colisepticemia
  - Colisepticemia of respiratory origin (polyserositis)
  - **E. coli peritonitis syndrome in laying hens**
- Sequelae of colisepticemia
  - Meningitis/encephalitis
  - Panophthalmitis
  - Osteomyelitis/spondylitis

# Peritonitis In Laying Hens



- Severe sepsis and polyserositic lesions.
- Medium-high and repetitive mortality (0.3-1.71% weekly)
- Repetitive episodes in the affected flocks

# Peritonitis In Laying Hens



- Peritonitis
- Perihepatitis.
- Pericarditis.
- Oophoritis.
- Salpingitis.
- Splenomegaly.
- Pulmonary congestion.
- Arthritis.

Picture: Dinev

# Route Of Infection

Respiratory  
tract

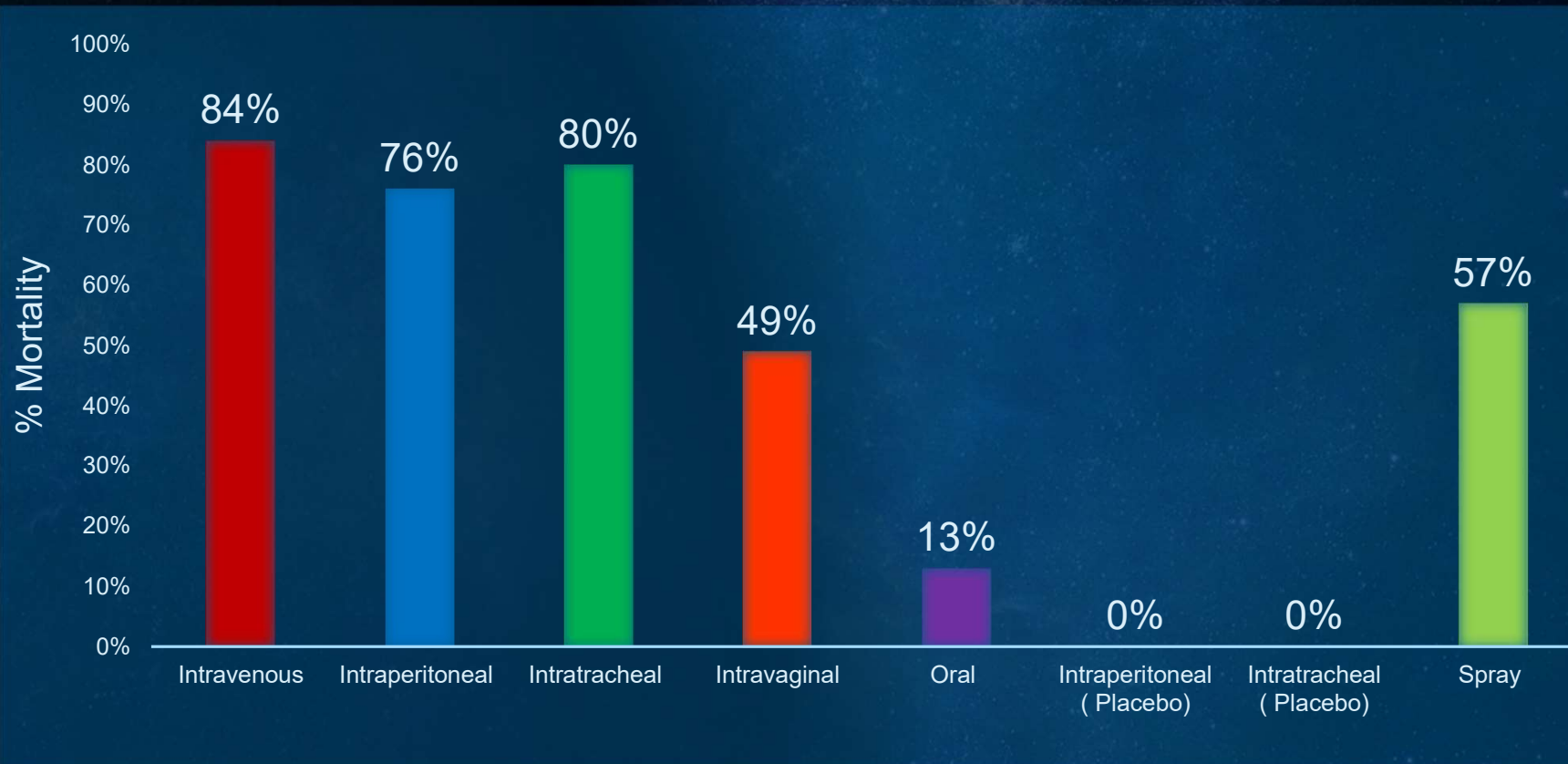
Reproductive  
tract

Intraperitoneal

Intestinal tract

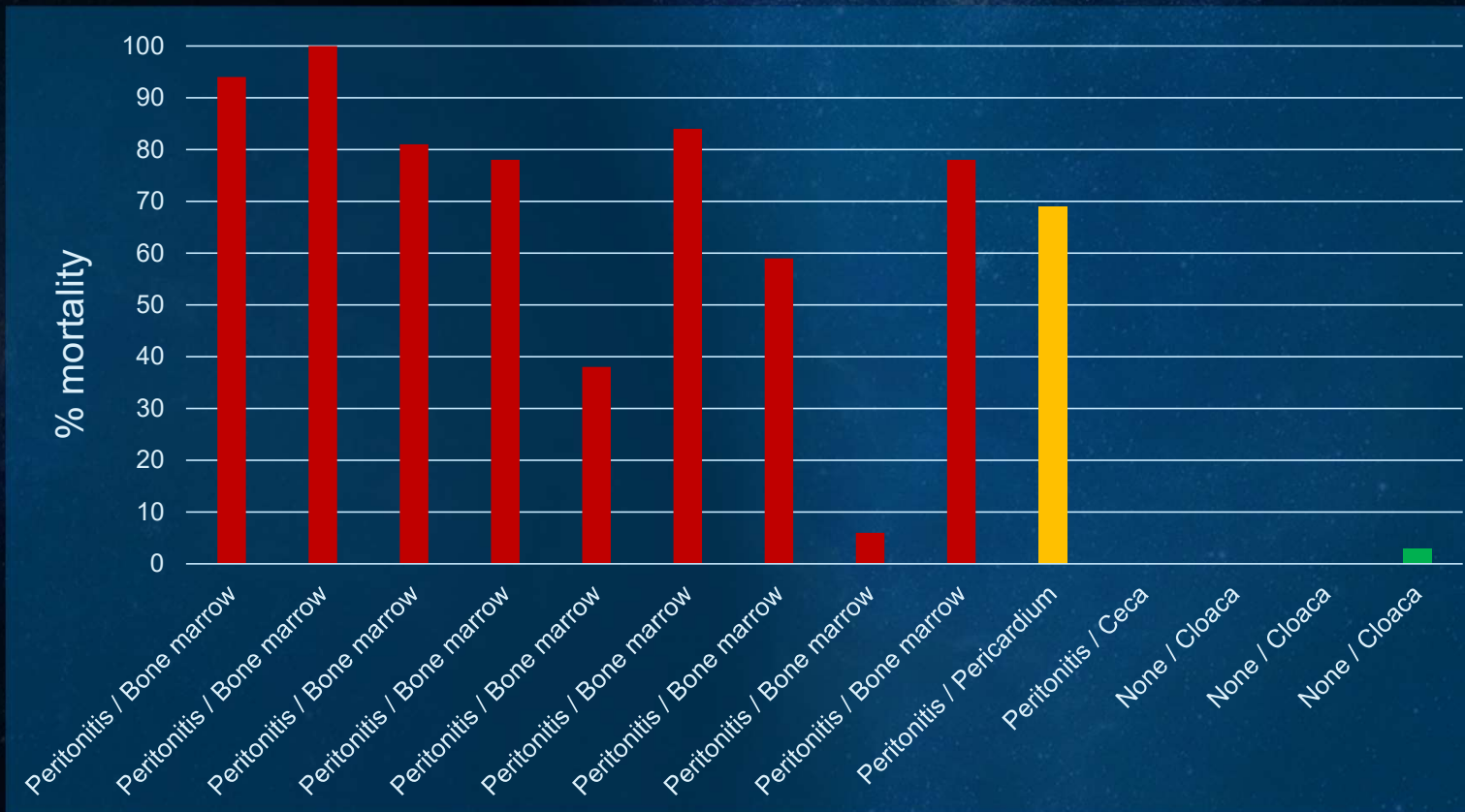
# Route Of Infection

Brown layers challenged by APEC



# Pathogenesis

## Different strains by pathology and place of isolation



# Control

## Prevention

Environmental  
control

Respiratory  
pathology  
control

Gut health

Vaccination

## Treatment

Antibiotics

Alternative  
treatments

Phage  
therapy?

# Air Quality In Layer Houses

Temperature

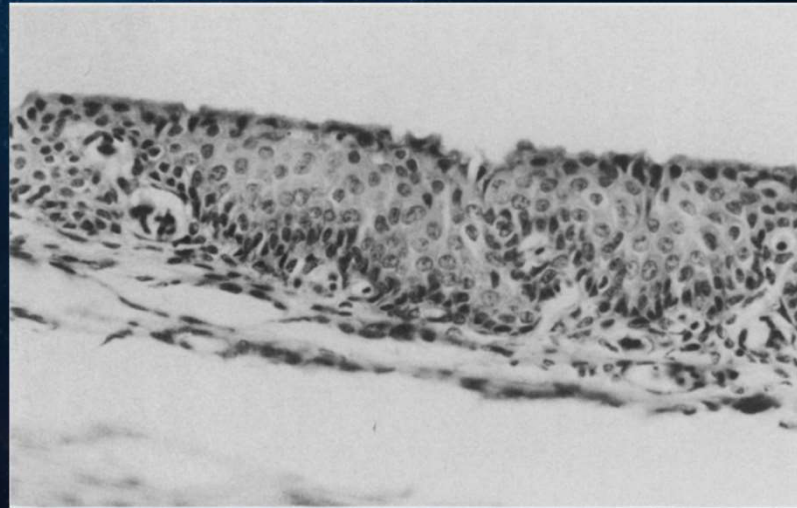
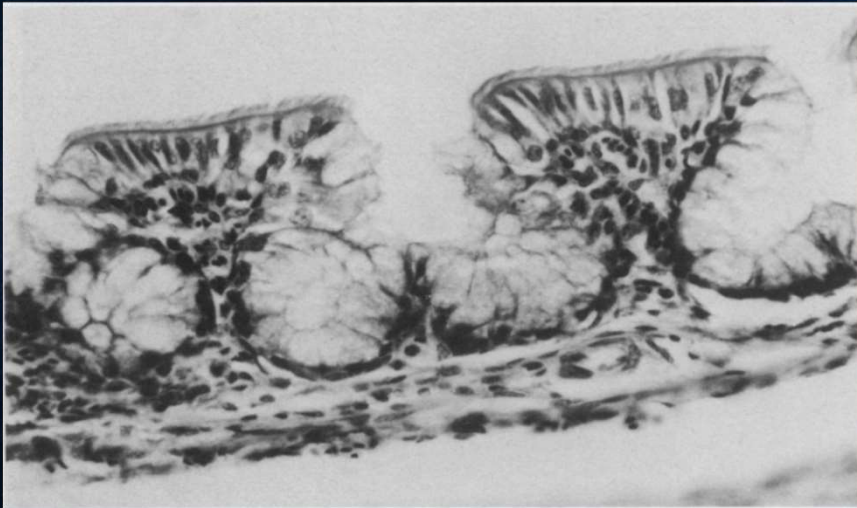
Ammonia  
> 20 ppm

Dust



# Trachea Lesions

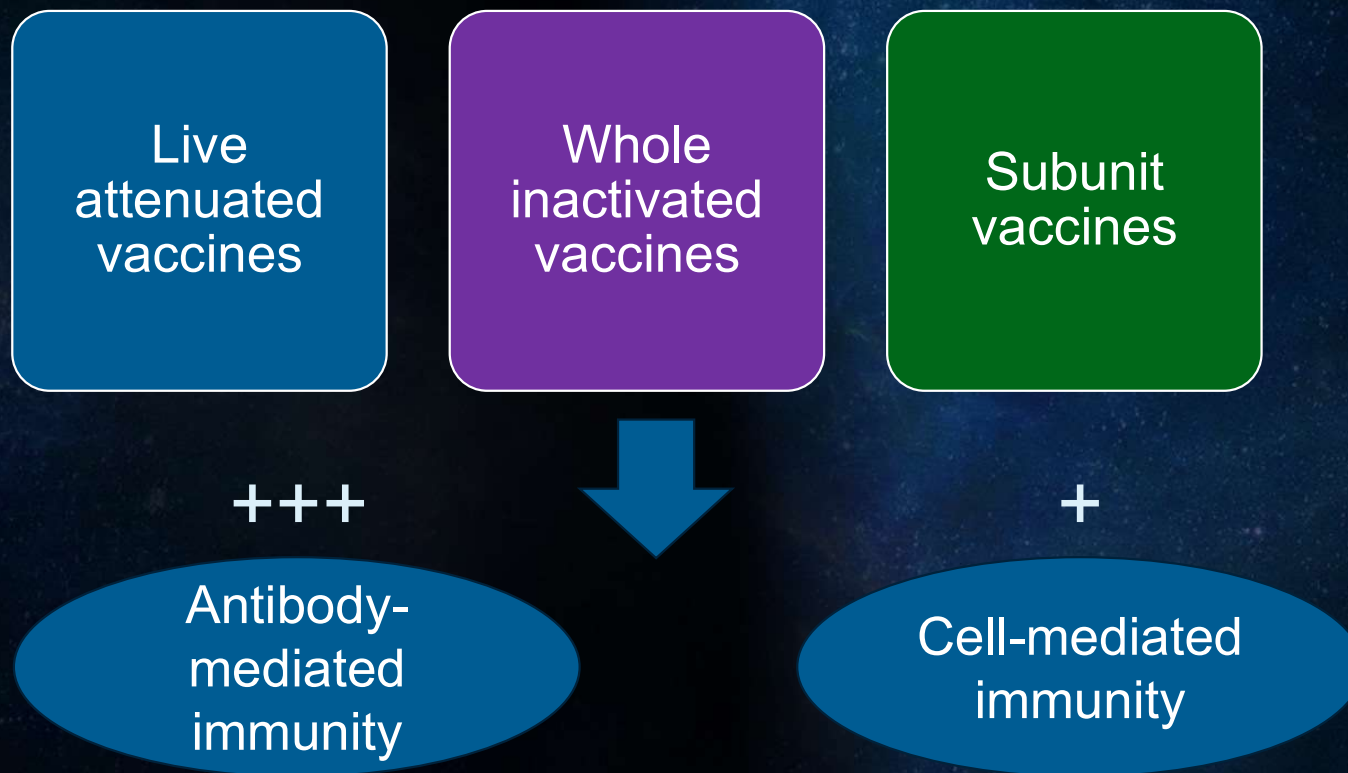
Trachea histology after exposure to ammonia, dust, and *E. coli* in light birds for 2 weeks



Source:  
Oyuntude 1978

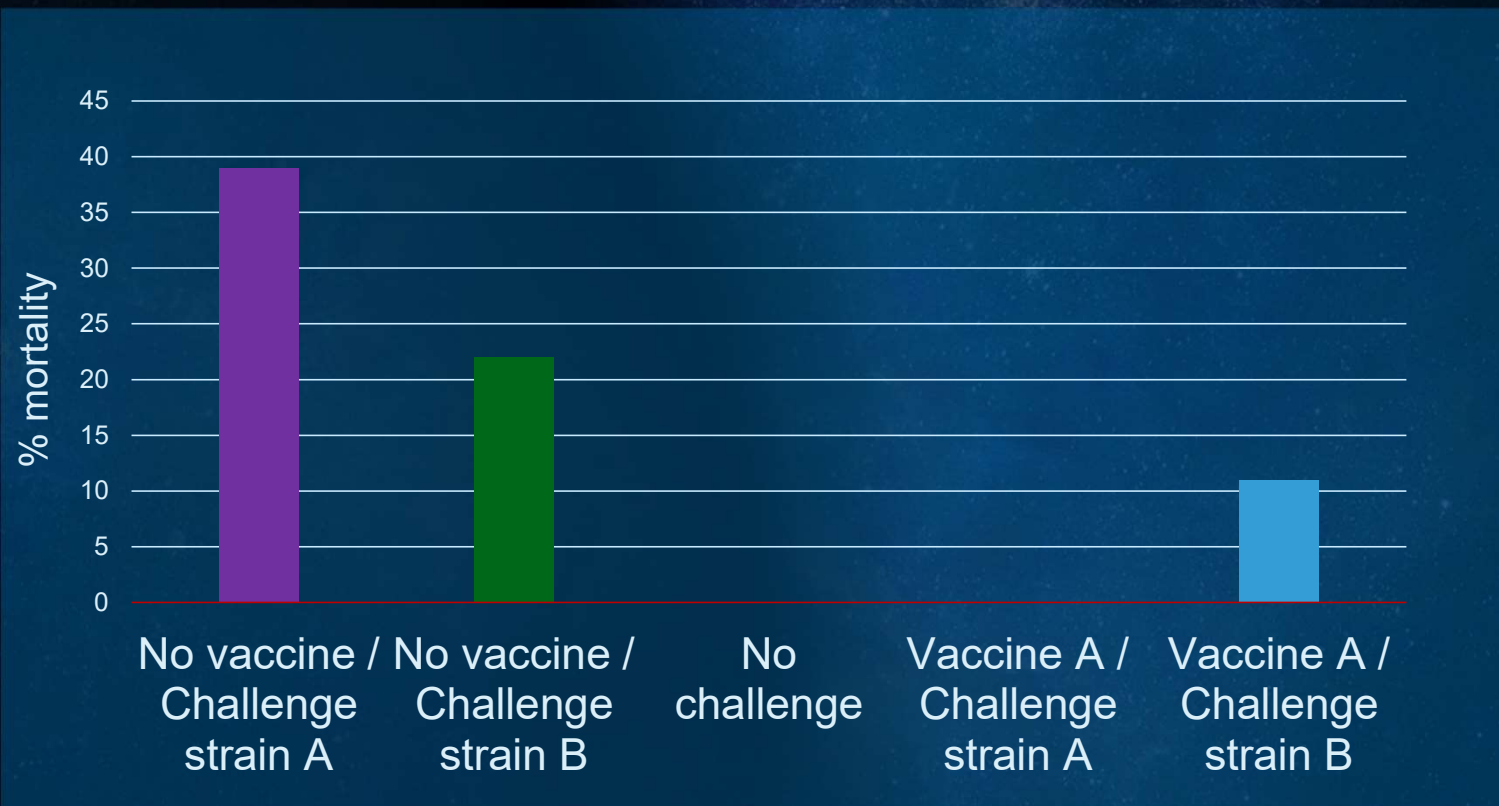
# Vaccination

## Types of vaccines and immunity

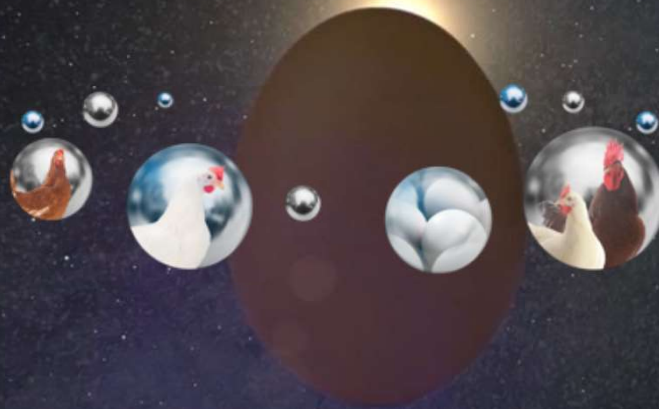


# Autogenous Vaccines

## Homologue strain protection vaccine



# Thank you for your attention



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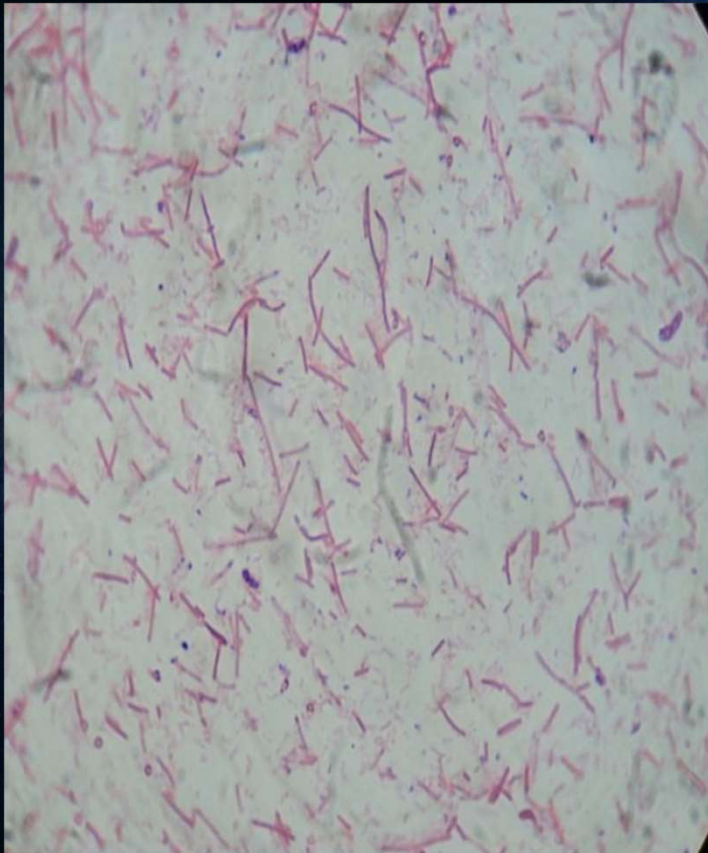


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## Bonus Track: Coryza



*Avibacterium paragallinarum*.  
Gram-negative bacterium.

It has a very short survival time  
outside the bird (48 hours).

Found worldwide.

It affects chickens, pheasants and  
guinea fowl.

Clinical cases can occur at any age.

# Bonus Track: Coryza

Page's scheme



Kume's scheme



# Bonus Track: Coryza

## Uncomplicated infection



Nasal secretions, sneezing, and swelling of the face below the eyes.

Reduced feed and water intake.

Decreased egg production (10–40%)

High morbidity and low mortality.

# Bonus Track: Coryza

## Uncomplicated infection



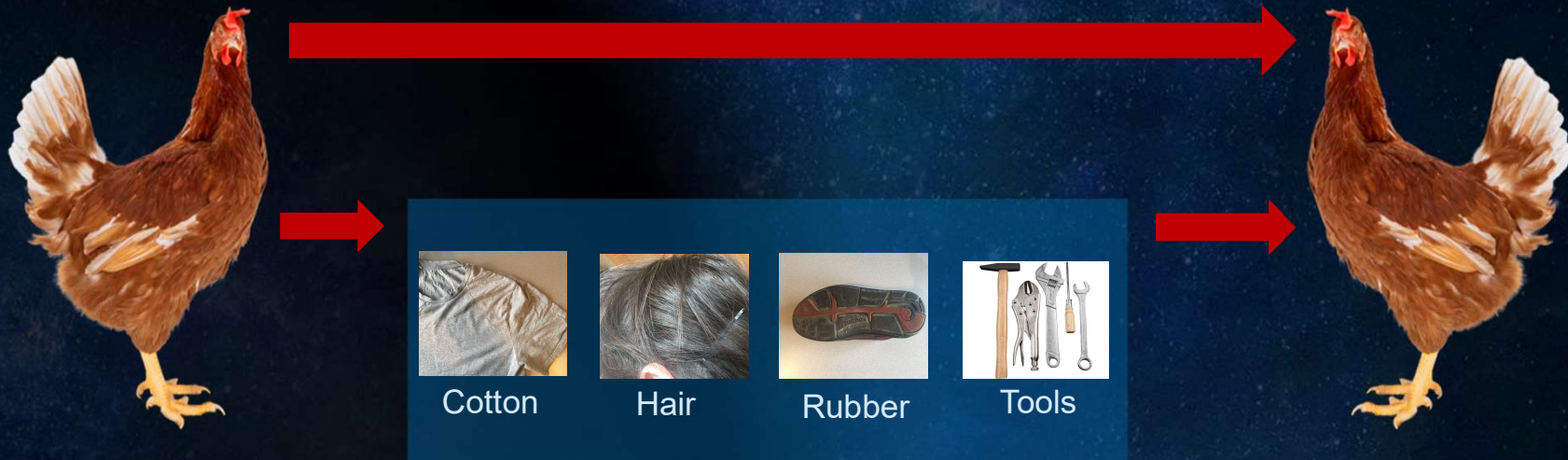
Caseous material in the sinuses.

Vision loss

Longer duration of illness and variable mortality.

# Bonus Track: Coryza

## Transmission



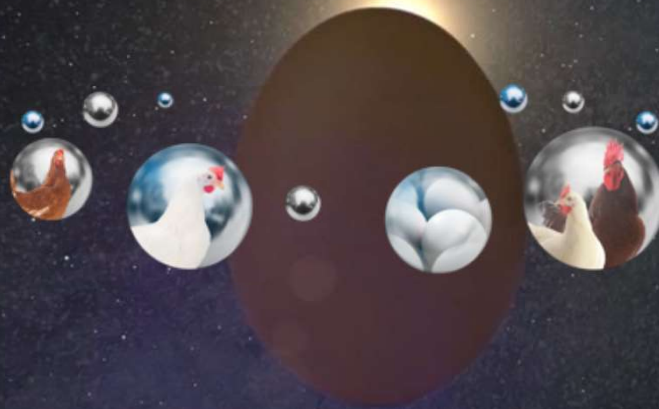
Asymptomatic carriers

# Bonus Track: Coryza

Vaccine type	Strains	Administration
Bivalent commercials	A, C	Intramuscular injection
Trivalent commercials	A,B,C	Intramuscular injection
Comerciales cuativalente	A,B,C + extra	Inyección intramuscular
Autogenous vaccines	?	Intramuscular injection

Bacterins only protect effectively against homologous strains

# Thank you for your attention



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