Phylum: **ALVEOLATA**

APICOMPLEXA
MONOXENOUS COCCIDIA SPECIES

EIMERIIDOSIS – morphology, location, the main species according the hosts, prevalence, life cycle, epidemiology, pathogenesis and clinical signs, pathology, diagnosis, methods of treatment and prevention.

CRYPTOSPORIDIOSIS – morphology, location, the main species, prevalence, the life cycle, epidemiology, pathogenesis and clinical signs, pathology, diagnosis, methods of prevention and control.

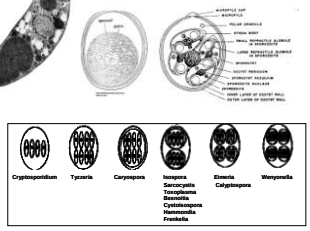
Phylum: **ALVEOLATA**

- Subphylum: **APICOMPLEXA**
- Subphylum: **CILIOPHORA**
- Subphylum: **DINOFLAGELLATA**

Veterinary Significant

APICOMPLEXA

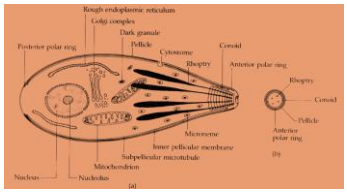
- **Obligatory intracellular parasites**
- Single-celled organisms
- All species are **parasitic, medically significant**
- **Strict specificity:** **host**, **topic/organ**, **age**
- **Simple nucleus, no cilia or flagella**
- Subphylum is characterized by the presence of the complex apical organelles ***„apical complex"***, found at the apical end of the **developmental stages** of sporo**zoites** and mero**zoites**
- **Zoit (sporozoit, merozoit)** – **gliding moving**, actively searches the target cell;
- **Oocysts** - **immobile form**; the internal structure depends on the species

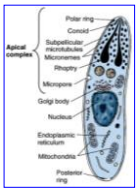


The Apical Complex

- **polar rings**
- **the conoid**
- **subpellicular microtubules**
- **rhoptries (2-4)**;
- **Micronems + Dense granules**

„Secretory glands" - flows at the peak of Zoit

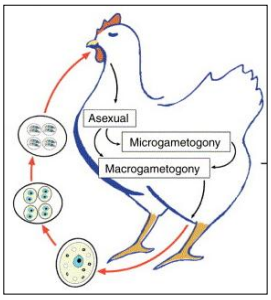




Life cycle – Monoxenous

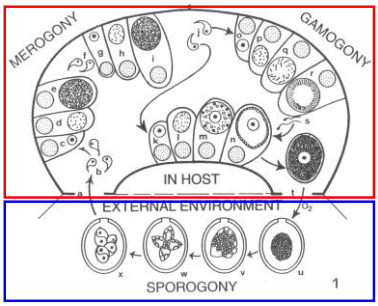
One-host life cycle

Eimeria, Cryptosporidium, Isospora



Life cycle has **3 major phases**:

- **merogony** (**schizogony**, produces **merozoites**)
- **gametogony** (produces **gametocystes**), and
- **sporogony** (produces **sporozoites**)



Class: **COCCIDEA**

Order: **EIMERIDA**

Family: **Eimeriidae**

Eimeria, Isospora

Order: **CRYPTOSPORIDA**

Family: **Cryptosporididae**

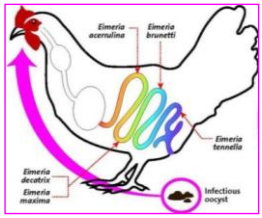
Cryptosporidium

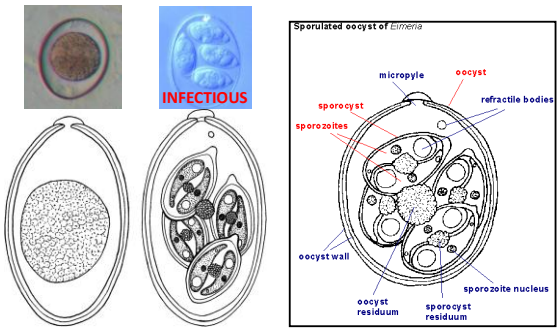
MONOXENOUS COCCIDIA

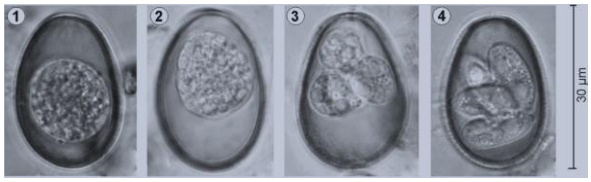
COCCIDIOSIS DISEASE

Genus: *Eimeria*

- veterinary importance;
- The wall of the oocysts consists of 2 layers of resistant material;
- *Eimeria* species are **highly host specificity** and species are **highly site (topic) specificity;**

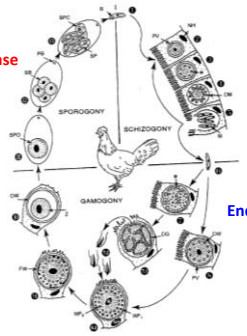






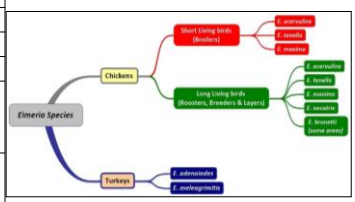
4 sporocysts; 2 sporozoits in each

Exogenous phase



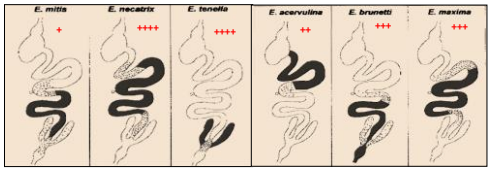
Endogenous phase

Eimeria tenella	chicken/cecum
Eimeria maxima	chicken/small intestine
Eimeria necatrix	chicken/small intestine
Eimeria praecox	chicken/small intestine
Eimeria danilovi	ducks/small intestine
Eimeria adenoides	turkey/colon, cecum
Eimeria meleagrimitis	turkey/small intestine

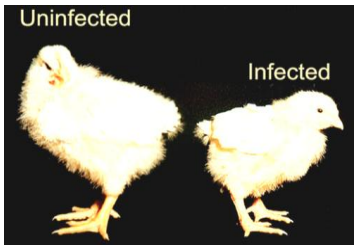


Chicken eimeriosis

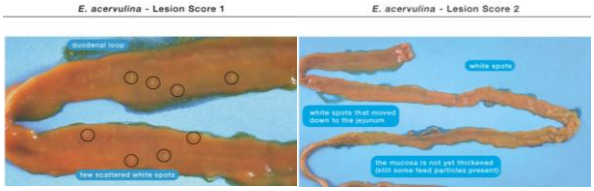
Is characterized as **catarrhal-hemorrhagic enteric disease**, **diarrhoea**, **CNS disorders**, **anaemia**.
The disease occurs primarily in animals (chicks) placed in high concentrations on small areas.



Clinical signs and pathogenesis

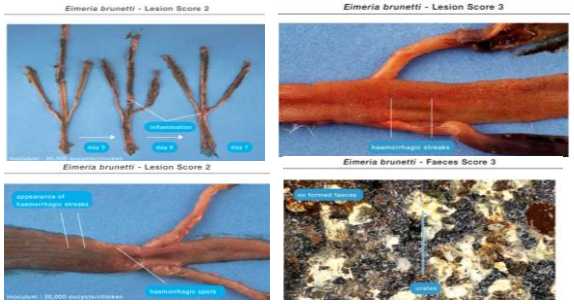


E. acervulina – duodenum; rarely ileum
Pre-patented period of 4 days



E. maxima **- jejunum and beginning of ileum**

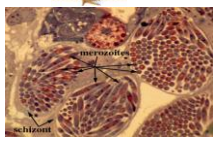
E. brunetti **– illeum, rectum, cloaca**



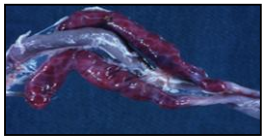
E. necatrix **– jejunum, ileum, caeca**

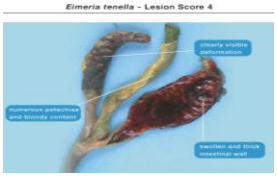
Eimeria tenella – caeca

- schizonts I. generation – 900 merozoites
- schizonts II. generation – 300 merozoites
- schizonts III. generation ⟺ gamogony



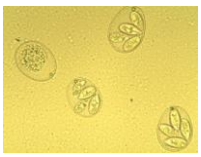
- pre-patent period 7–10 days
- highest mortality 4–6 days p.i.





Diagnosis

- ***Intra vitam*** – coprological examination - flotation method - find **oocysts**;
- ***Post mortem*** – scratches of the epithelial layers of the intestine, histological sections;



Coccidiosis - Treatment for Chickens

Treatment of coccidiosis involves several important components:

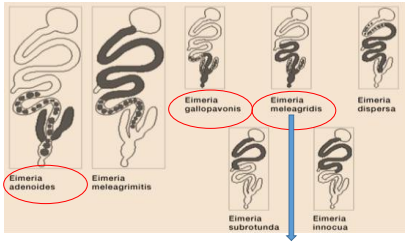
- **Anticoccidial agents** - amprolium, sulphonamides, clopidol, ionophores or toltrazuril;
- **Antibiotics** - tylosin or amoxicillin;
- **Supportive care.**
- **Environmental/Management Changes.** Slow down oocyst sporulation by removal of the feces and soiled bedding, ensuring it is kept dry.
-

VACCINE

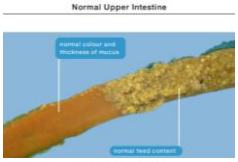
Coccidiosis in Turkeys

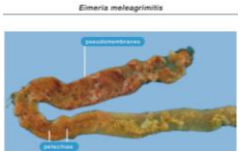
In turkey there are **three** economically important *Eimeria* spp. that infect primarily growing turkeys between 3 and 10 weeks of age.

- ***E. meleagrimitis*** - **upper and middle** intestine
- ***E. adenoeides***
- ***E. gallopavonis*** - multiplies in the **caecal pouches**



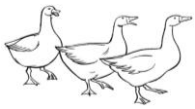
(syn. *E. meleagrimitis*)





Eimeriosis of ducks and geese

Eimeria danilovi
Ducks / ileum 8-day pre-patented period highly pathogenic

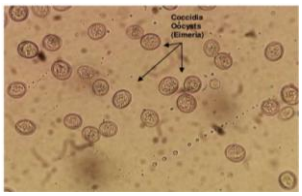


E. Perniciosa
(ileum)

E. anseris (ileum)
E. nocens (ileum)
E. parvula (ileum)
E. truncata (kidney)

Pigeons

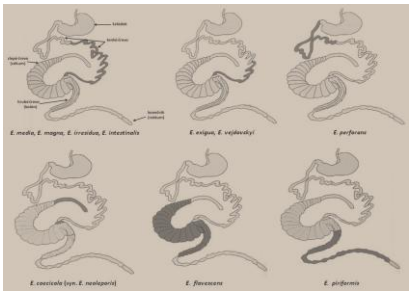
Eimeria labbeana
Eimeria columbaria

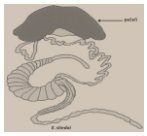


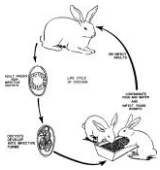
Coccidiosis in Rabbits

- highly contagious characterized by **enteritis, hepatitis** and **high** young rabbits **mortality**

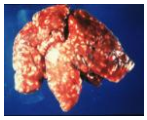
Species	Location	Number of asexual generations	Average size oocysts (length x wide) in µm	Patogenicity
E. coecicola	apendix	4	38,8x24,9	non-pathogenic species
E. exigua	duodenum-ileum (proximal and distal part small intestine)	4	18x16	slightly pathogenic
E. perforans	duodénum	2	18,6x14,6	slightly pathogenic
E. vejdovskyi	ileum	5	31,5x19,1	slightly pathogenic
E. media	duodénum-jejunum - illeum	3	30,6x17,1	pathogenic
E. magna	jejunum-ileum	4	36,5x23,4	pathogenic
E. irresidua	jejunum-ileum	4	32,4x18,6	pathogenic
E. piriformis	large intestine	4	30,6x17,1	pathogenic
E. stiedai	liver	5-6	34x20,2	pathogenic
E. intestinalis	jejunum-ileum	3-4	29,4x19,5	highly pathogenic
E. flavescens	caeca	5	30x21	highly pathogenic







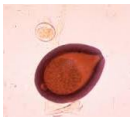
Symptoms



Treatment

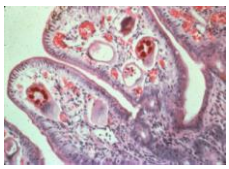
- Decoquinate
- **Diclazuril**
- Formolsulphathiazol
- Metichlorpindol/methylbenzoquate
- **Monensin**
- **Robenidine**
- **Salinomycin**
- Sulphadimethoxine
- Sulphadimidine/diaveridine
- Sulphaquinoxaline
- Sulphaquinoxaline/ pyrimethamine
- **Toltrazuri**l
- **Sulphonamides**

Horses – *Eimeria leukarti*



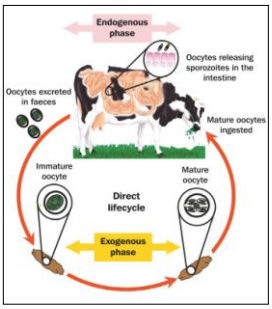
➢ **Oocyst large (~58 x 87 microns - thick- walled), dark brown, resembles melon seed with micropyle - heavy, use sedimentation technique**

➢ Post mortem, the **catarrhal inflammatory changes** of the small intestine, such as the **reddened mucosa**, have been detected by **small, gray-colored nodules** of the pin head size;

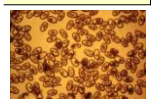


➢ When diarrhea is confirmed by eimeria, we deliver **sulphonamides** orally, e.g. **sulfadimidine 7-15 mg /kg**.

Bovine *Eimeriosis*



Species	host/habitat	oocyst size (µm)	prepatent period (days)	pathogenicity
Eimeria bovis	cattle/ posterior small intestine	23-34 x 17-23	18-21	yes
Eimeria auburnensis	cattle/small intestine	36-42 x 19-26	17-18	yes
Eimeria zuernii	cattle/small intestine	16-20 x 15-18	16-19	yes



Eimeria bovis

➢ 1st generation meronts in endothelial cells of posterior half of small intestine

➢ 2nd generation meronts in cecal and colonic epithelium

➢ Gamonts in epithelial cells of cecal and colonic glands

➢ Diarrhea, tenesmus, fever, congested mucosa, often edematous and hemorrhage;

➢ Death 3-4 weeks p.i.

➢ Partial immunity following recovery

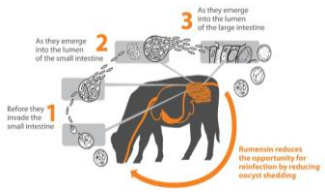

Eimeria zuernii

➢ 1st generation throughout small intestine

➢ 2nd generation ileum, colon, caecum

➢ Gamonts colon and caecum

➢ Death beginning 7 days of onset of symptoms - may not be passing oocysts at this time



Treatment of coccidiosis in cattle

➢ **Amprolium Corid® 10 mg/kg daily for 5 days**

➢ **Sulfaquinoxaline 2.72 mg/kg daily for 3-5 days**

➢ **Sulfamethazine 110 mg/kg daily for 5 days**

Prophylaxis of coccidiosis in cattle

- **Lasalocid Bovatec® 1 mg/kg per day, maximum 360 mg/day**
- **Decoquinate Deccox® 22.7 mg/100 lb. daily for 28 days**
- **Monensin Rumensin® 100 to 360 mg/head per day**

Eimeriosis in Sheep and Goats

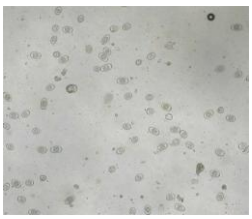
- *E. ahsata*
- *E. bakuensis (E. ovina)* ☠
- *E. crandailis*
- *E. faurei* ☠
- *E. granulosa*
- *E. intricata* ☠
- *E. marsica*
- *E. ovinoidalis* ☠

- *E. palida*
- *E. parva*
- *E. weybridgensis*
- *E. ninakohlyakimovae* ☠
- *E. arloingi* ☠
- *E. christenseni* ☠
- *E. gilruthi (abomasum)*

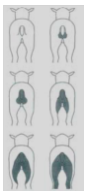
Species	host/habitat	oocyst size (µm) X x Y range	Prepatent period (days)	Pathogenicity
Eimeria faurei	 sheep/small intestine	22-33 x 19-24	14-15	yes
Eimeria intricata	sheep/small intestine, cecum	40-56 x 30-41	20-27	yes
Eimeria ovina	sheep/small intestine	23-36 x 16-24	19	yes
Eimeria ovinoidalis	sheep/colon	17-25 x 13-20	10-15	yes
Eimeria arloingi	 goats/intestinal crypts	25-33 x 16-21	20	yes
Eimeria ninakohlyakimovae	goats/intestinal crypts	16-28 x 14-23	11-17	yes
Eimeria christenseni	goats/small intestine	34-41 x 23-38	?	yes

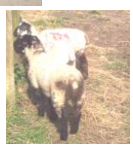
Lamb coccidiosis

- Occurs in young lambs, older sheep having become immune through previous contact with the parasite.
- Outbreaks occur mainly in lambs 4 - 8 weeks of age.



Lamb coccidiosis - Symptoms





Pig Eimeriosis

- *Eimeria debliecki, **E. scabra**, E. neodebliecki, E.spinosa, E. polita*
- ***E. suis;***
- Acute enteritis limited to **lower small intestine**
- Characteristic **yellow fibronecrotic pseudomembrane** often accompanied by **bloody diarrhea**
- Diagnose during acute prepatent phase by examination of gut

Species	Host/Habitat	Oocyst size (µm)	Prepatent period (days)	Pathogenicity
Eimeria scabra	 pig/small intestine	25-45 x 17-28	8-9	yes
Eimeria suis	pig/small intestine	13-20 x 11-15	10	yes

Eimeriosis of carnivores

- ***Eimeria canis***
- ***E. felina, E. cati***

} In combination with cystoisospora

- enteritis
- diarhoea
- polyury

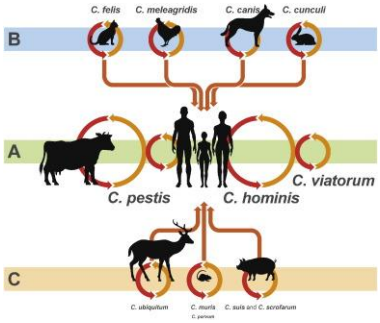
Diagnosis, therapy, prevention: as with other eimeridoses

Genus: ***Cryptosporidium*** – **low host specificity !**

- In September 2004, the World Health Organization (WHO) included cryptosporidiosis with giardiosis between "**Neglected Diseases Initiative**".
- Together with giardiasis, belong to **opportunistic infections** carried by contaminated water and food "**Waterborne and foodborne diseases**".

- At present, **34 valid species** of the genus *Cryptosporidium* are recognized based on host specificity, molecular differences, morphology oocyte and localization of the developmental cycle and **more than 60 genotypes** and **subgenotypes** based on molecular methods.
- **In mammals, 18 species of *Cryptosporidium* are recognized**: *C. muris, **C. parvum**, C. wrairi, C. felis, C. anderson, C. canis, C. hominis, C. suis, C. bovis, C. fayeri, C. macropodum, C. ryanae, C. xiao, C. ubiquitum, C. cuniculus, C. tyzzeri, C. viatorum a C. scrofarum;*
- **In humans, 13 species**: *Cryptosporidium hominis, **C. parvum**, C. meleagridis, C. felis, C. canis, C. suis, C. muris, C. andersoni, C. cuniculus, C. ubiquitum, C. viatorum, C. scrofarum, C. bovis;*
- Of them *C. hominis, C. parvum* are responsible for most of the *Cryptosporidium* infections in both immunocompetent and immunocompromised individuals;

- Within the genus, **we distinguish two morphologically diffrent groups**: the first is *Cryptosporidium* with smaller oocysts and **affinity for intestinal enterocytes**, e.g. *Cryptosporidium parvum* 5 x 4,5 µm, *C. canis, C. felis, C. hominis, C. bovis, C. suis* a iné.
- The other group has oocysts larger, oval, **affinity for stomach glands**, e.g. *C. andersoni* 8,4 x 6,2 µm, *C. muris, C.galli, C. serpentis*



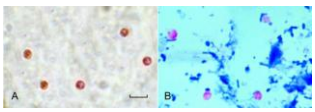
Cryptosporidiosis / Zoonosis

Cryptosporidium

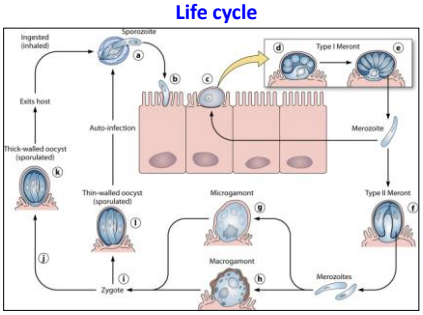
Special tissue localization – micro villuses of the **digestive tract** (intestine, gastric wall), **respiratory tract**;

The development takes place in the parasite-form vacuole resulting from inversion of zoit after invasion by host cell excisions; called "**Intracellular extracytoplasmic**" localization.

Intracelular but Extracytoplasmic Location



Life cycle



PATHOGENESIS

- **HYPERTROPHY OF CRYPT CELLS**
- **ABBREVIATION** OF VILLUSES
- **INFLAMATION** IN **LAMINA PROPRIA MUCOSAE**

SECRETION OF WATER BY CELLS OF CRYPT
SECRETION DIARRHOEA WITHOUT PARTICIPATION OF ENTEROTOXIN

Clinical signs (calves)

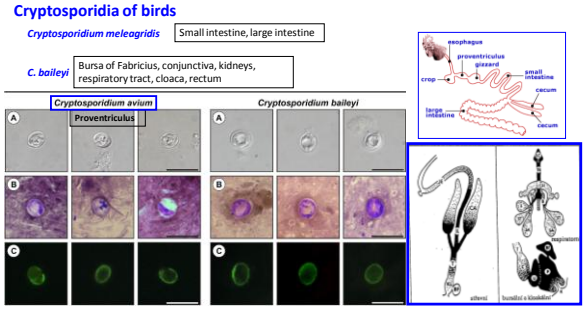
INCUBATION: 5 - 8 days

- neonatal profuse diarrhoea and complete destruction of microvilli of the intestine;
- light-yellow faeces;
- salivation, anorexia, exsiccosis, acidosis, fever, apathy, weakness;
- **frequent defecation, malodorous**, watery faeces (fibrin, mucus, ...)

Cryptosporidia of birds

Cryptosporidium meleagridis — Small intestine, large intestine

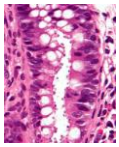
C. baileyi — Bursa of Fabricius, conjunctiva, kidneys, respiratory tract, cloaca, rectum

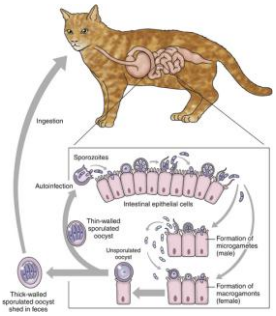


DOGS and CATS

Cryptosporidium canis, C. muris, C. parvum, C. meleagridis

Cryptosporidium felis, C. muris





Therapy in animals

- **Halofuginone** (Halocur) – 0.1 mg/kg b.w. orally daily for 7 consecutive days for calves
- Nitayoxanid
- Azitromycin
- Pyrvinium pamoate

- Symptomatic treatment - hydration, electrolytes, nutrition

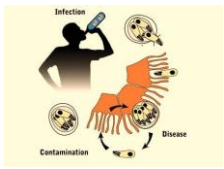
Animal	Active substance	Dose	Length of treatment
Dog, cat	**Paromomycin**	125 – 165 mg/kg	1x daily 5 days
Dog, cat	**Azitromycin**	10 – 15 mg/kg	1x daily 5-7 days
Dog, cat	**Nitazoxanid**	10 – 25 mg/kg	2x daily 7 days
Dog, cat	**Tylozin**	10 – 15 mg/kg	2x daily 14 days

Human Cryptosporidiosis

- **Serious disease in the young, pregnant women, patients undergoing chemotherapy and elderly**
- **Potentially fatal in immundeficient hosts**
- **Infectious dose in healthy humans is low: ID_{50} about 130 oocysts**
- Watery diarrhea (can be several times a day)
- Stomach cramps
- Upset stomach
- Slight fever
- Weight loss

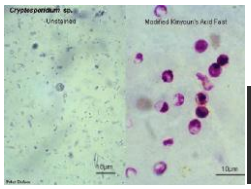
Cryptosporidium: Public Health Significance

- **Worldwide prevalence about 10%**
- **Zoonosis, human and animal genotypes**
- **Oocysts ubiquitous in surface waters**
- **Difficult to remove, and hard to kill**
- **Drinking water - amplifier for disease**
- **Up to 20% of general population may be considered at higher risk**

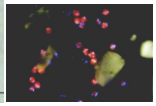


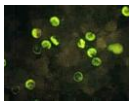
Diagnosis of cryptosporidiosis

- Observe oocysts in floats, stained films (acid fast stains, fluorescent antibody, ELISA);



- Stains:
  - Kinyoun's Acid Fast or DMSO AF (Trend)
  - HOT Ziehl Neelson modified AF
    - sporozoites = RED, all else - green





Incubation Period & Duration

- **Incubation Period**
  - 1-12 days

- **Duration**
  - **In healthy people, symptoms usually last about two weeks or less**

- There is **no drug to cure cryptosporidiosis**
- Since diarrhea can cause dehydration, drink plenty of fluids.

Prevention

Cryptosporidiosis prevention **involves adequate sanitation** and **hand washing**, particularly in health care facilities and day care centers and after contact with soil, animals, or infected people.
People **should not drink or swallow water** that could be contaminated, such as that from a swimming pool, stream, or lake or in an area where sanitation is poor.

When public health departments discover a **localized outbreak of the disease**, they typically advise people to:
Boil drinking water (including water for tooth brushing and food washing)
Eat only cooked foods
Avoid unpasteurized milk and juice