Gastrointestinal Mucoflagellates

Giardia

Tritrichomonas blagburni
(AKA *T. foetus*)

Parasitic Protozoa we cover

Grouped by Infection Site and Motility

Apicomplexa
(sg =Alveolates)

Flagellates
(sg = Excavates)

Blood

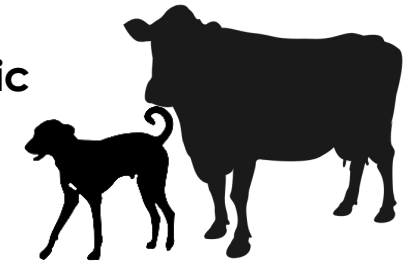
Blood apicomplexa (piroplasms)

Babesia spp.
Cytauxzoon felis
Theileria spp.

Hemoflagellates

Trypanosoma cruzi
Leishmania infantum

Systemic



Systemic apicomplexa

Toxoplasma gondii
Neospora caninum
Sarcocystis spp.
Hepatozoon americanum

Intestines/ urogenital

Intestinal apicomplexan (coccidia)

Cryptosporidium parvum
Eimeria spp.
Cystoisospora spp.

Mucoflagellates

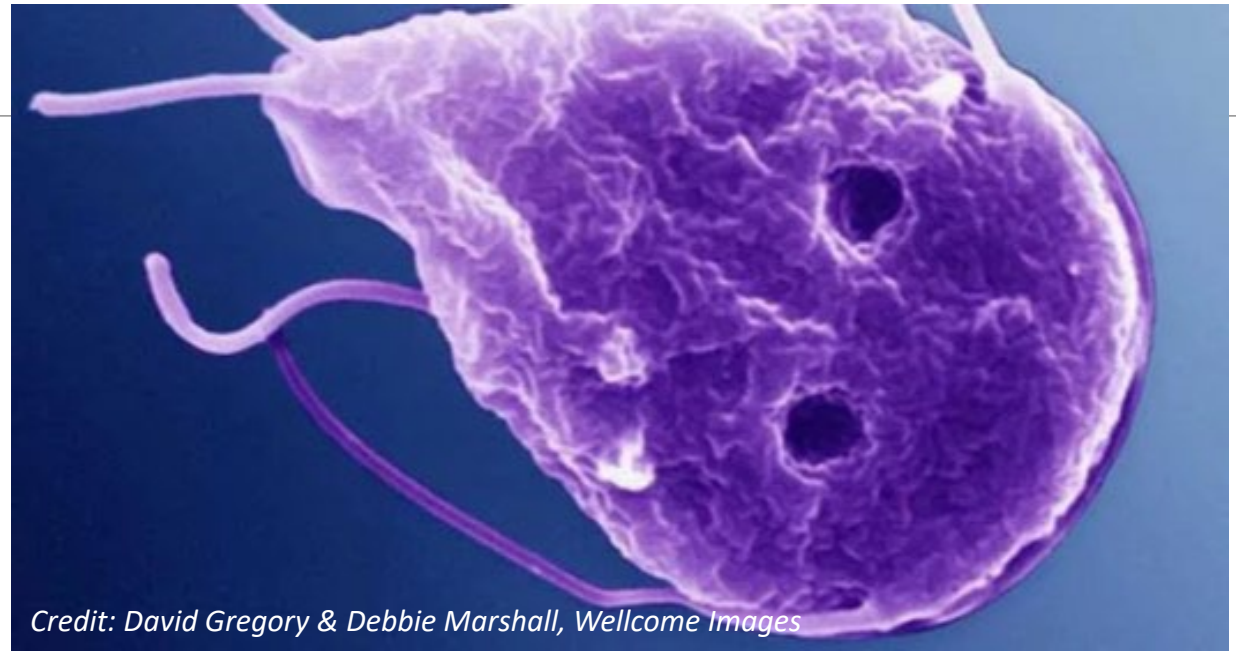
Tritrichomonas foetus (bovine venereal)

Tritrichomonas blagburni
Giardia spp.

Mucoflagellates Introduction

Tritrichomonas spp.

Giardia spp.



- Pear or spindle-shaped with flagellum (multiple)
- Only asexual replication
- Reside in mucous membrane-lined anaerobic-to-microaerophilic, non-sterile organ cavities (urogenital tract or gastrointestinal tract)

History

“Frye” 3 mo, MN viszla-pitbull mix

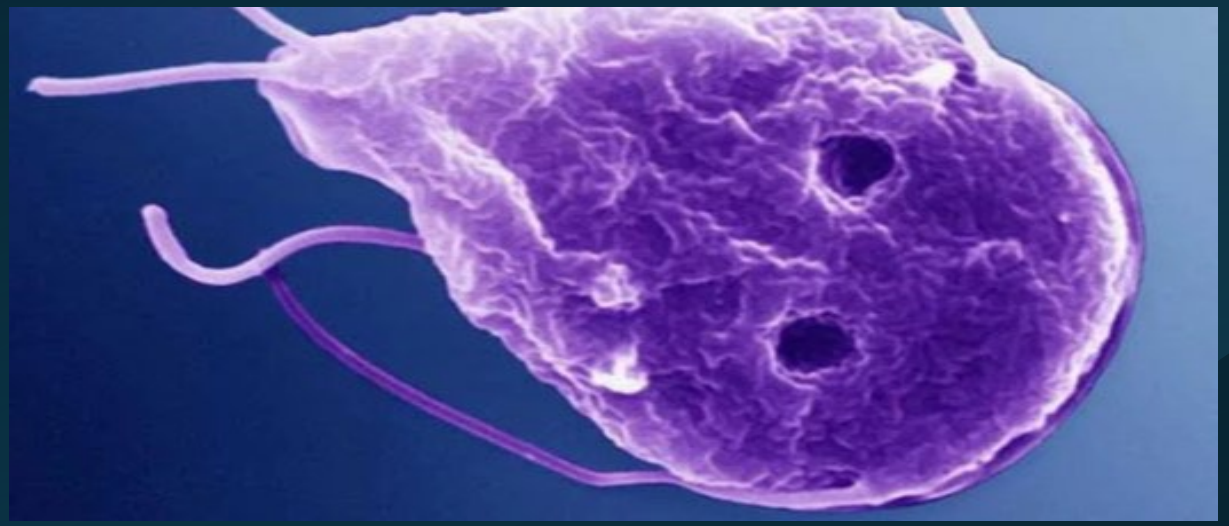
- Recently adopted from shelter
- Diarrhea ~ 3x a day, is like soft serve ice cream, no blood, no urgency, no straining
- Appetite is good
- Bright and alert, playful

PE

- Pale, soft, loose stool
- BCS 4/9
- Everything else WNL

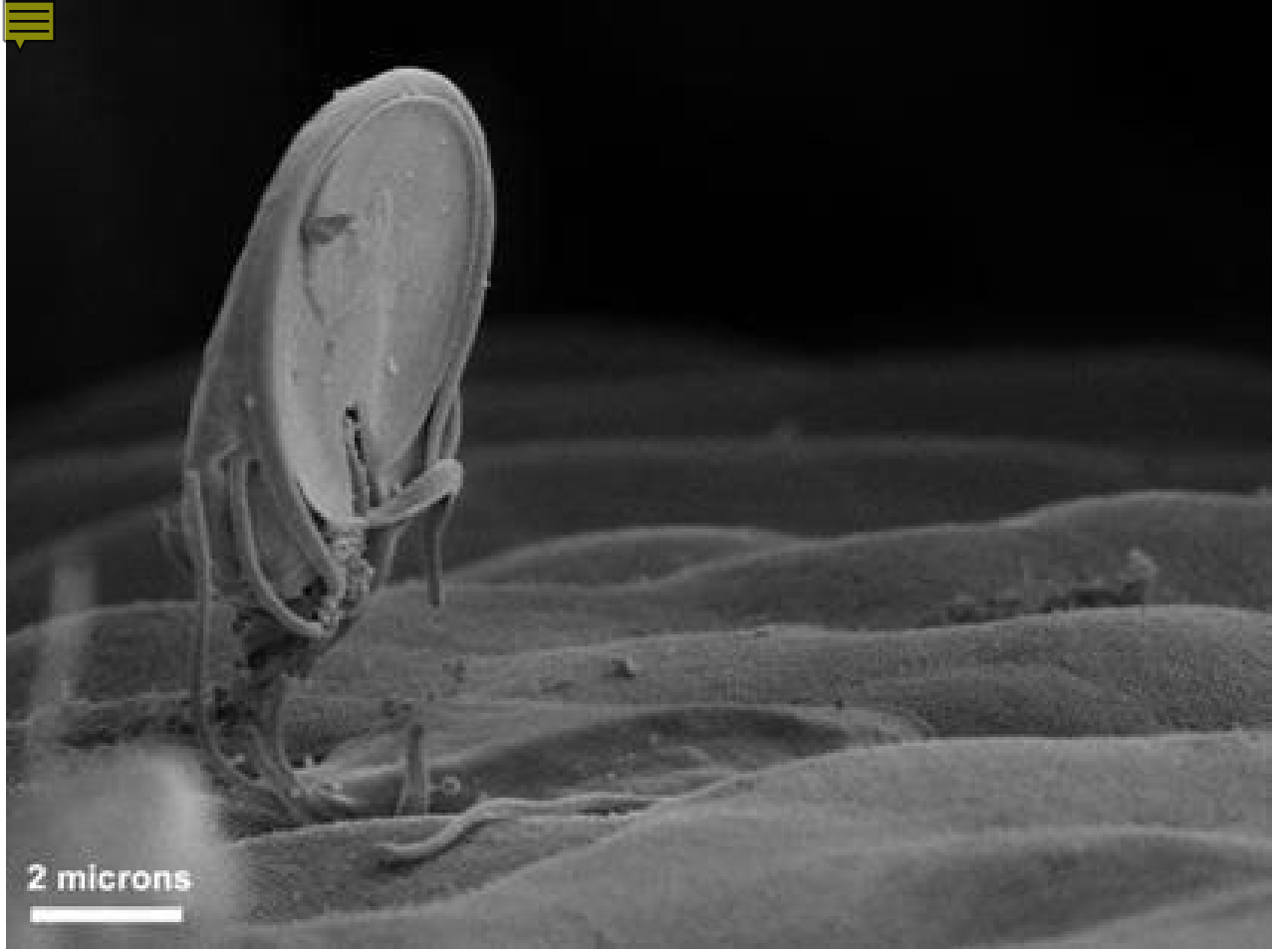
Diagnostics

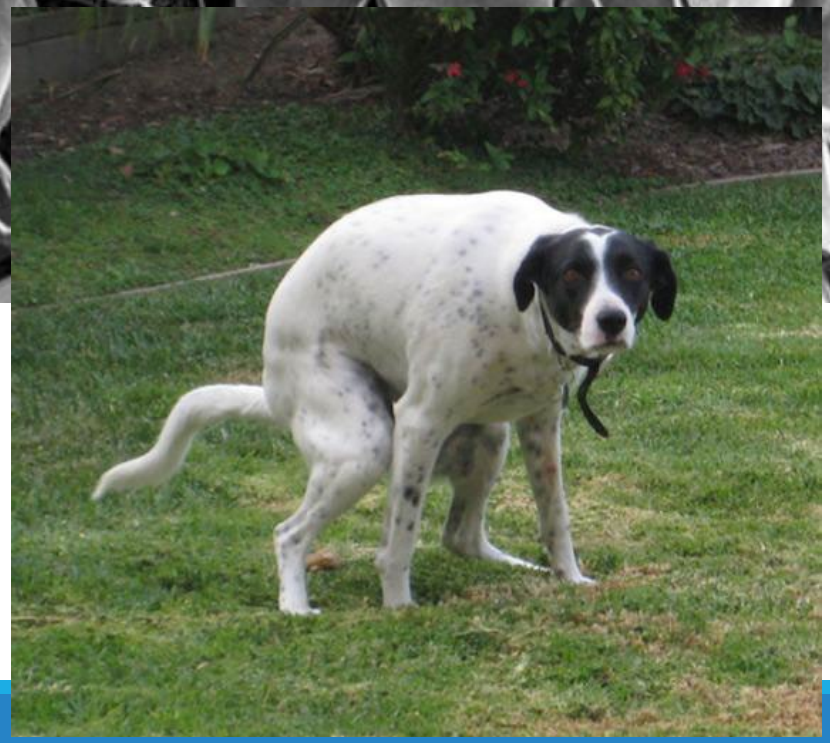
Fecal float centrifugation
Antigen detection ELISA kit



Mucoflagellates

Giardia





Giardiasis

Can cause small bowel diarrhea

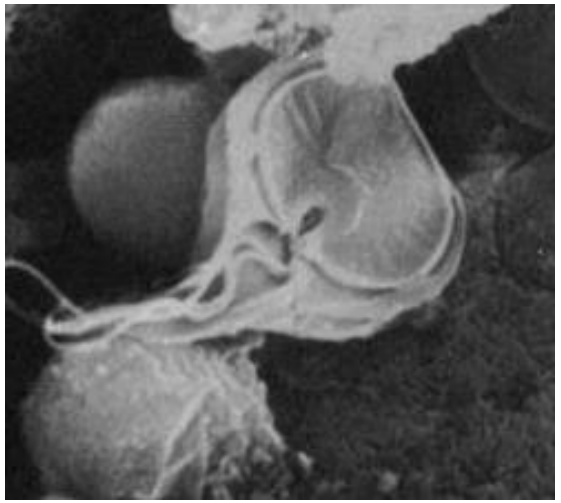
G. duodenalis is part of a species complex including *G. intestinalis, G. lamblia*.

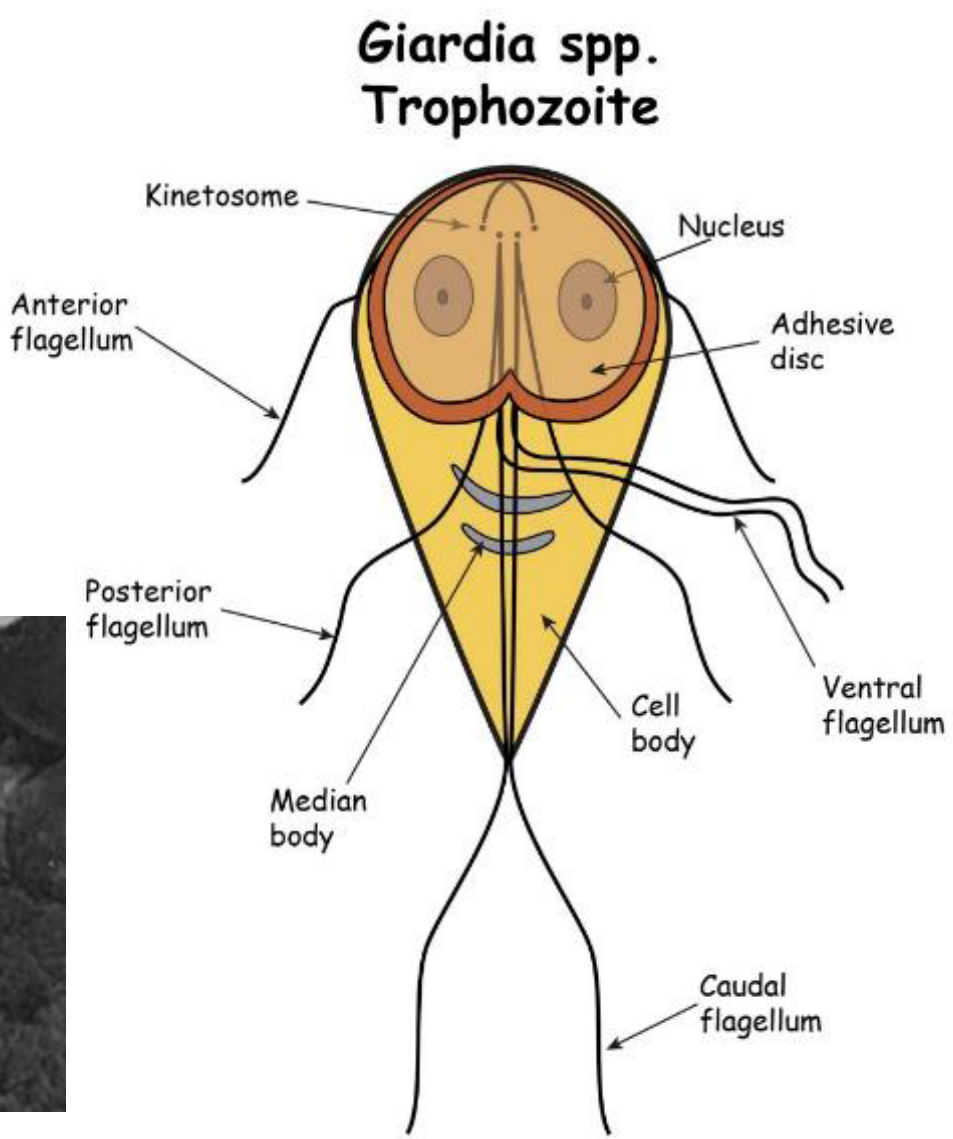
Learning Objectives: *Giardia*

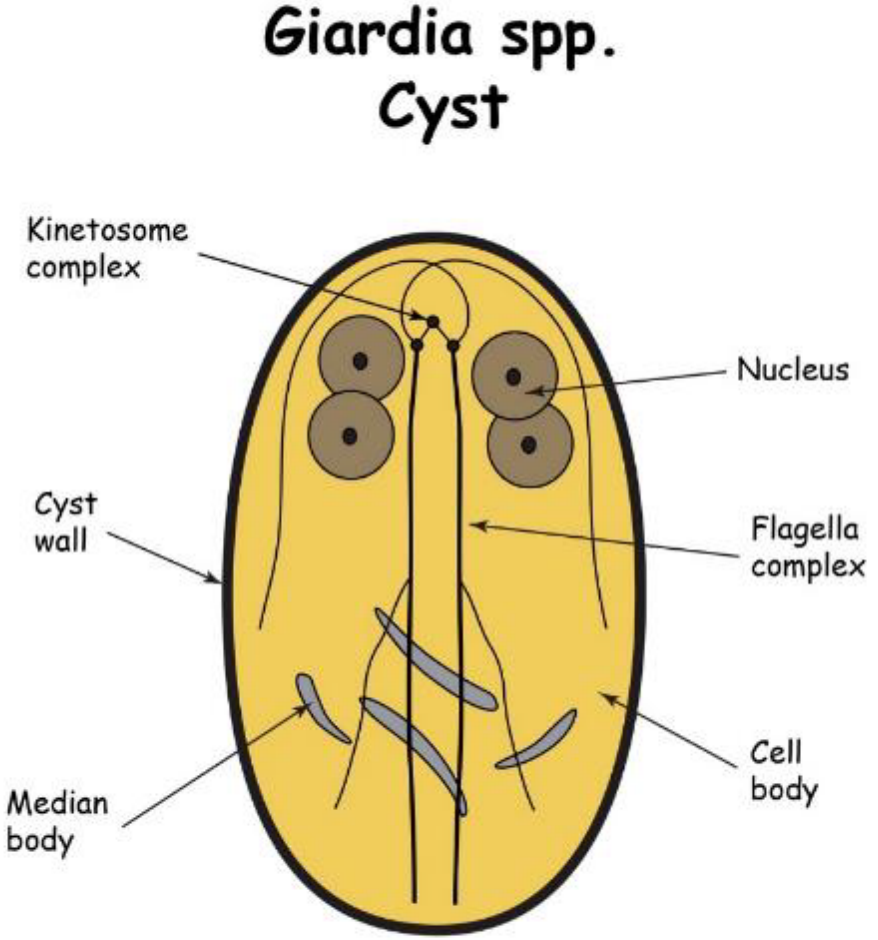

Credit: David Gregory & Debbie Marshall, Wellcome

1. Life cycle: understand the life cycle (hosts, transmission, stages and reproduction).
2. Transmission: understand how it is transmitted, why the stage of *Giardia* is important in transmission.
3. Pathogenesis: understand where in the GI tract it causes disease and how.
4. Clinical signs: recognize the discussed clinical signs.
5. Diagnosis: understand the methods used for diagnosis.
6. Control: understand how to control infection.
7. Epidemiology: recognize risk factors for infection.
8. Zoonosis: understand that *Giardia* have high host specificity, so zoonosis is rare. Know how to test for zoonotic assemblages.

Giardia Morphology







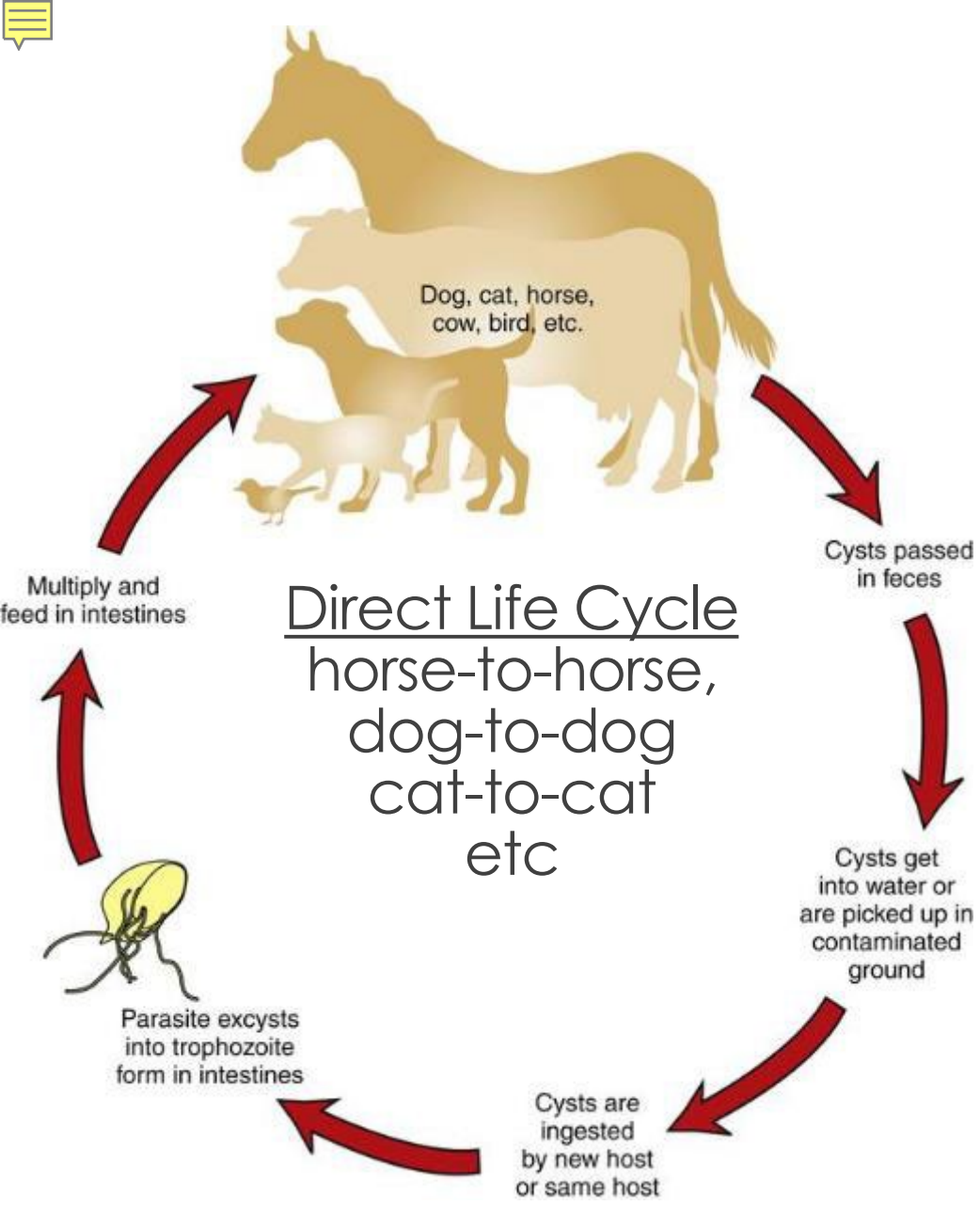
FYI: naming the different parts

Giardia Morphology

More fluid the stool the more trophozoites

More solid the stool the more cysts

Direct Life Cycle: *Giardia*



Primary Host

1. many species
2. colonizes small intestines on mucosal surface

Transmission is Fecal-oral

1. Ingest cysts
    a. feces
    b. contaminated water, food, fomites, self-grooming
2. Not trophozoites (they will not survive the stomach)

Stages

1. trophozoite (active, noninfective)
2. cysts (dormant, infective)

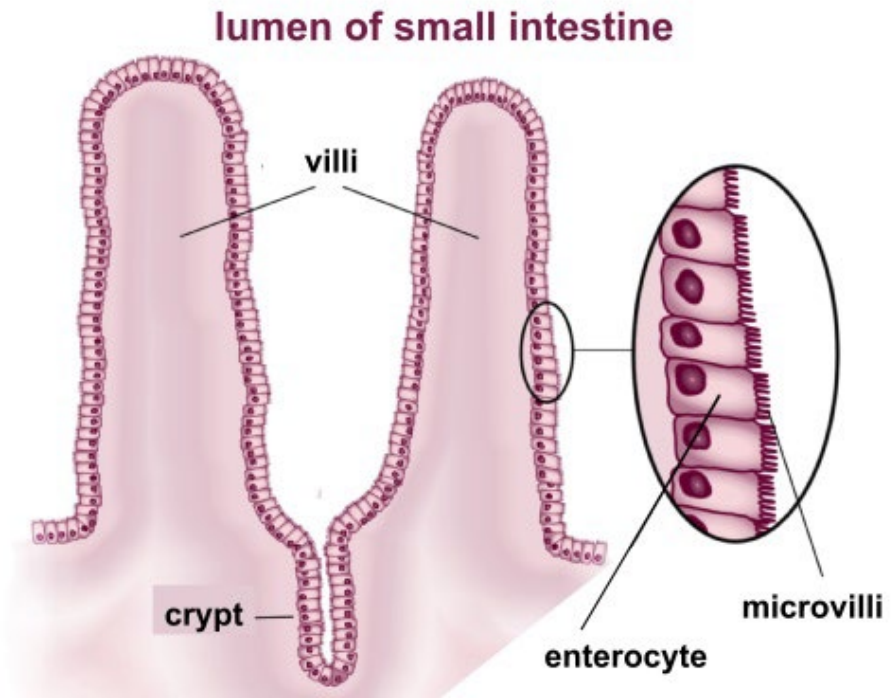
Reproduction

1. binary fission of trophozoites

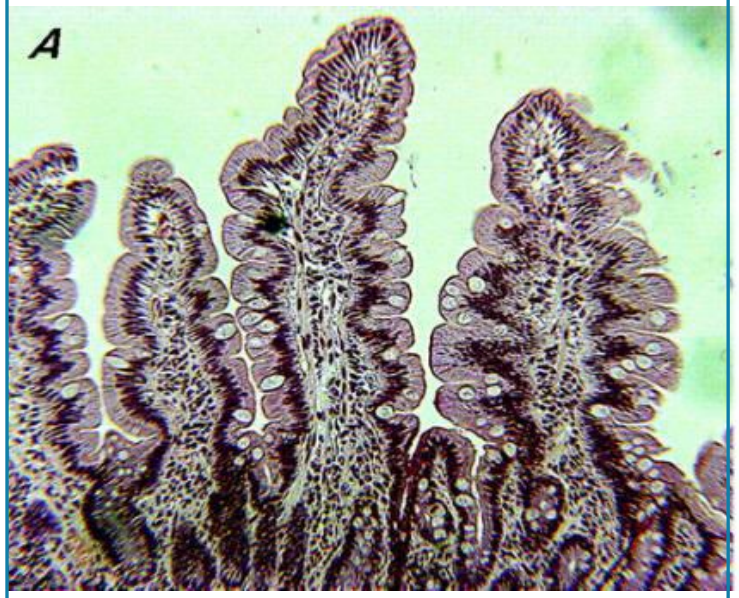
Image: https://veteriankey.com/common-protozoans-that-infect-domestic-animals/

Pathogenesis: *Giardia*

Indirect destruction: trophozoite attaches to surface of small intestinal → damages epithelial cells and enterocytes → GI permeability and blunts intestinal villi and microvilli → reduced surface area → **maldigestion, malabsorption, hypersecretion → DIARRHEA**



Normal duodenum



Chronic giardiasis:
blunted villi; reduced mucosal surface area

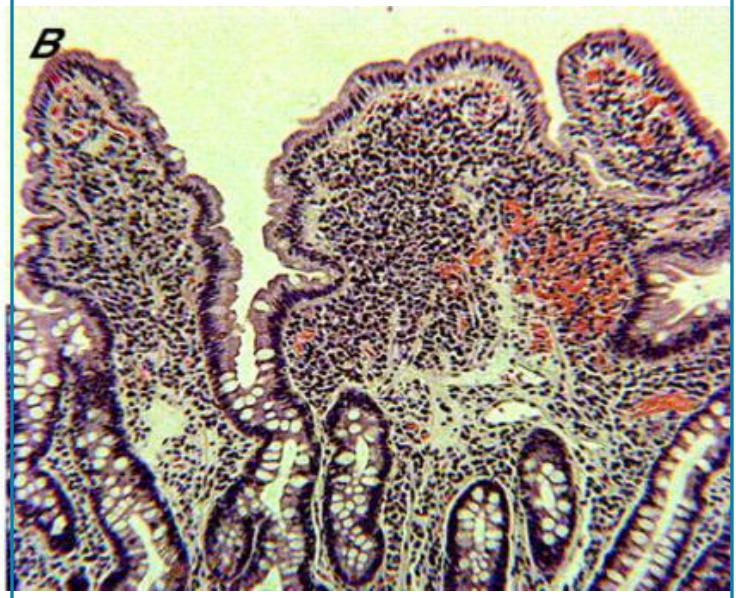


Image: Troeger, Hanno, et al. "Effect of chronic Giardia lamblia infection on epithelial transport and barrier function in human duodenum." *Gut* 56.3 (2007): 328-335.

Clinical Disease: *Giardia*

- **Persistent Diarrhea**: mucoid, pale, soft, loose, fatty (**blood is uncommon**); typical of small bowel diarrhea; can be acute, intermittent or chronic
- +/- vomiting, anorexia, dehydration
- **Some animals are subclinical** but shed giardia
  - (*Giardia* also a commensal organism??)
- **Malabsorption syndrome**
  - **signs of poor nutrition – lethargy, weight-loss**, etc.

Diagnosis: *Giardia*

Direct microscopic fecal analysis

Loose stool: motile trophozoites on fresh wet-mounts

Fecal float centrifugation

Solid stool: cyst stage (*don't confuse with yeast*)
use fecal float centrifugation with zinc sulfate solution
Recommended for routine screening

Antigen (cysts) detection kits, ELISA

Rapid in-house; ↑ Specificity
Not recommended for routine screening

PCR

KeyScreen GI Parasite (Antech); ↑ Specificity and Sensitivity;
Giardia assemblage typing ***Not recommended for routine screening*** *unless owner concerned (immunosuppressed)*

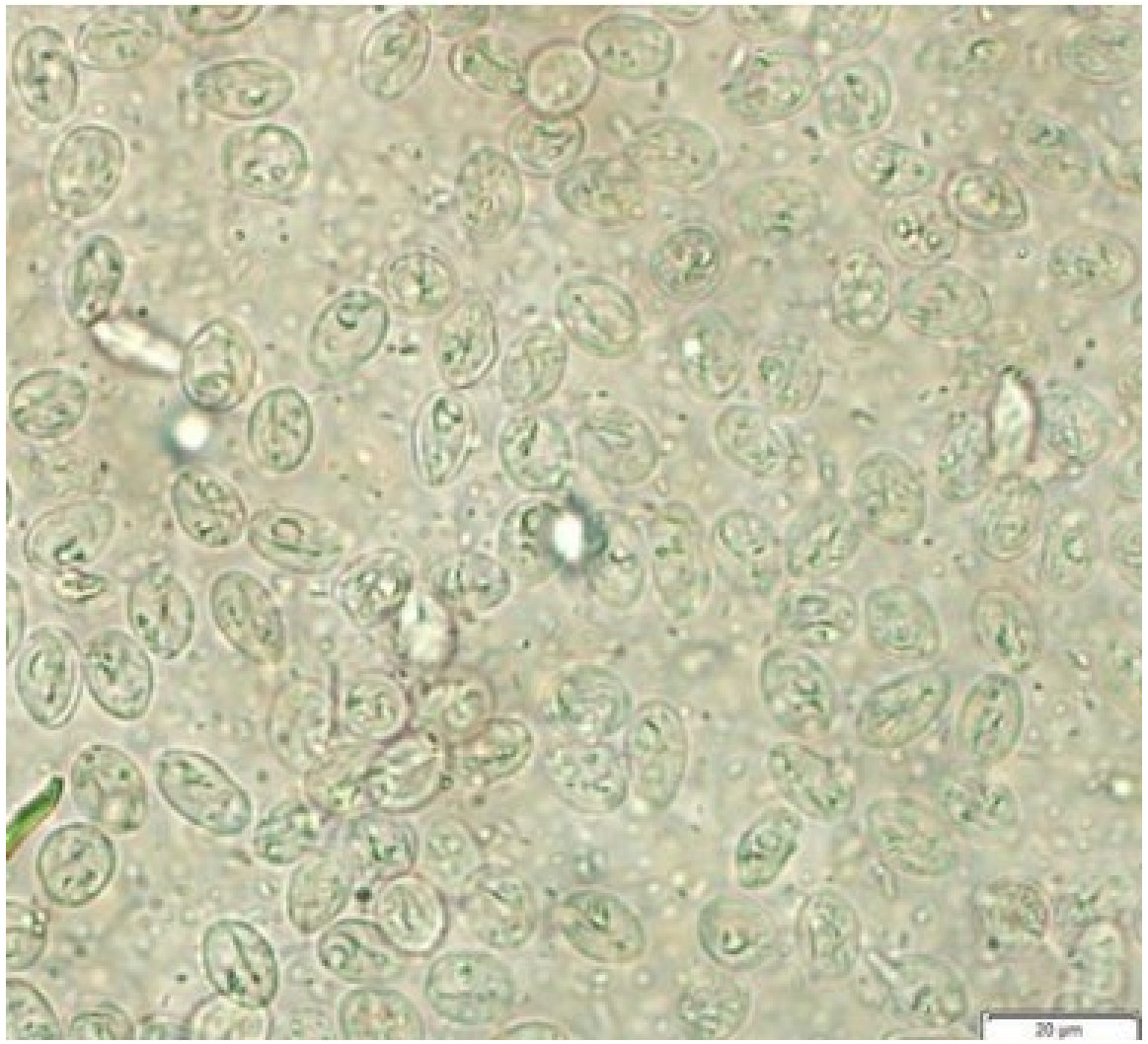
Saleh, Meriam N., et al. "Comparison of diagnostic techniques for detection of Giardia duodenalis in dogs and cats." *JVIM* (2019).

Uiterwijk, Mathilde, et al. "Comparing four diagnostic tests for Giardia duodenalis in dogs using latent class analysis." *Parasites & vectors* 11.1 (2018): 439.

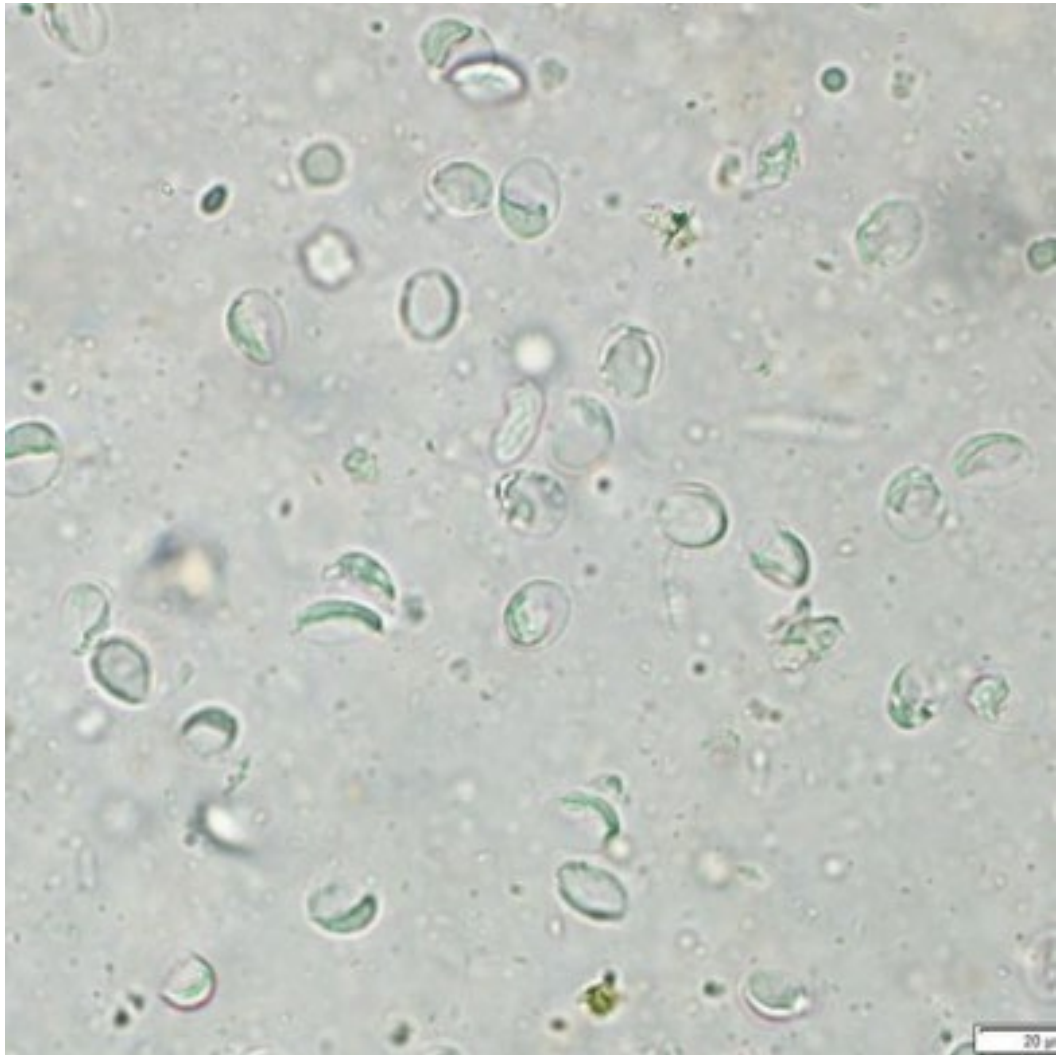
Fecal float centrifugation

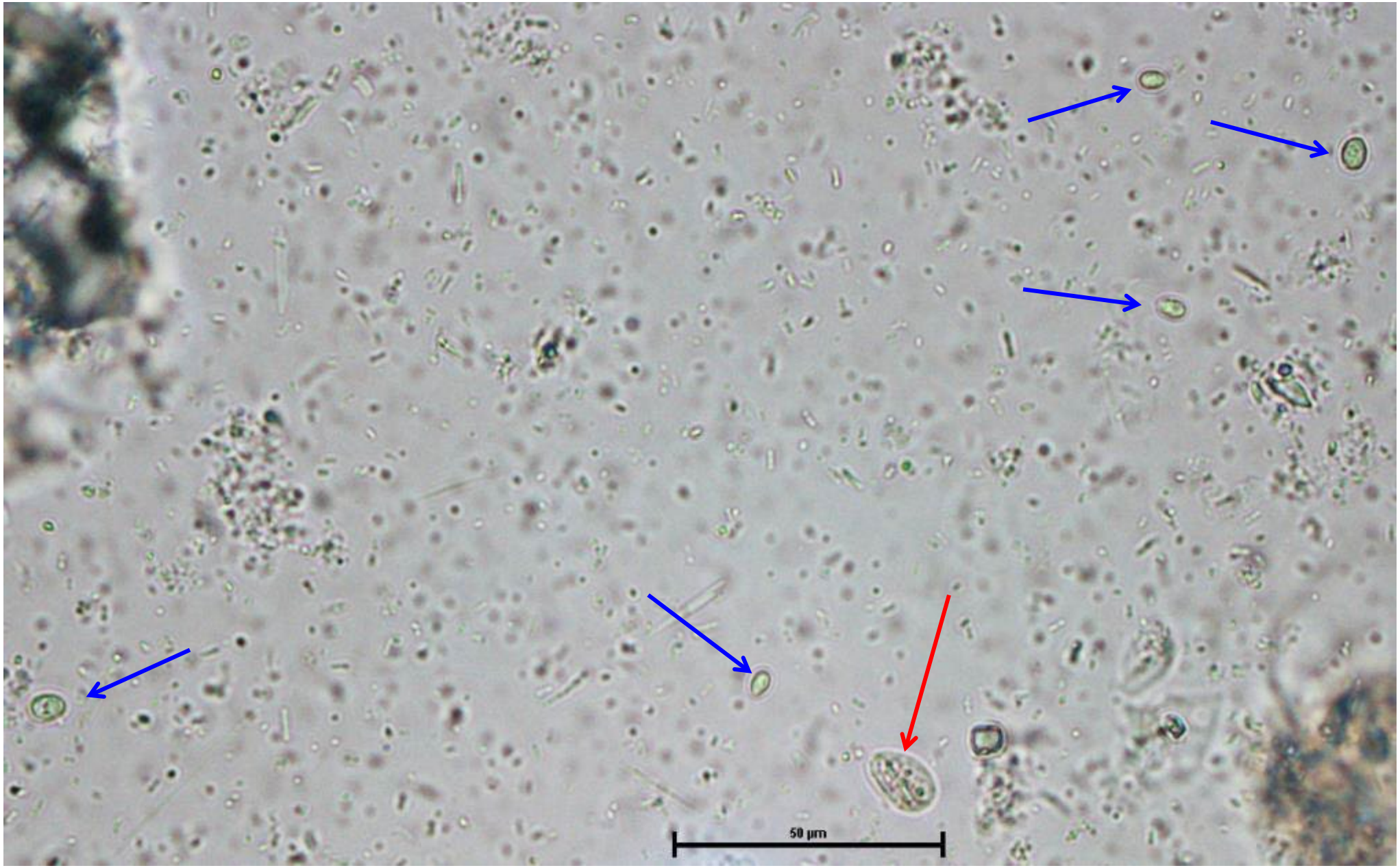
use fecal float centrifugation with zinc sulfate solution

zinc sulfate solution (SG = 1.18)



Sheather's sugar solution (SG = 1.275)





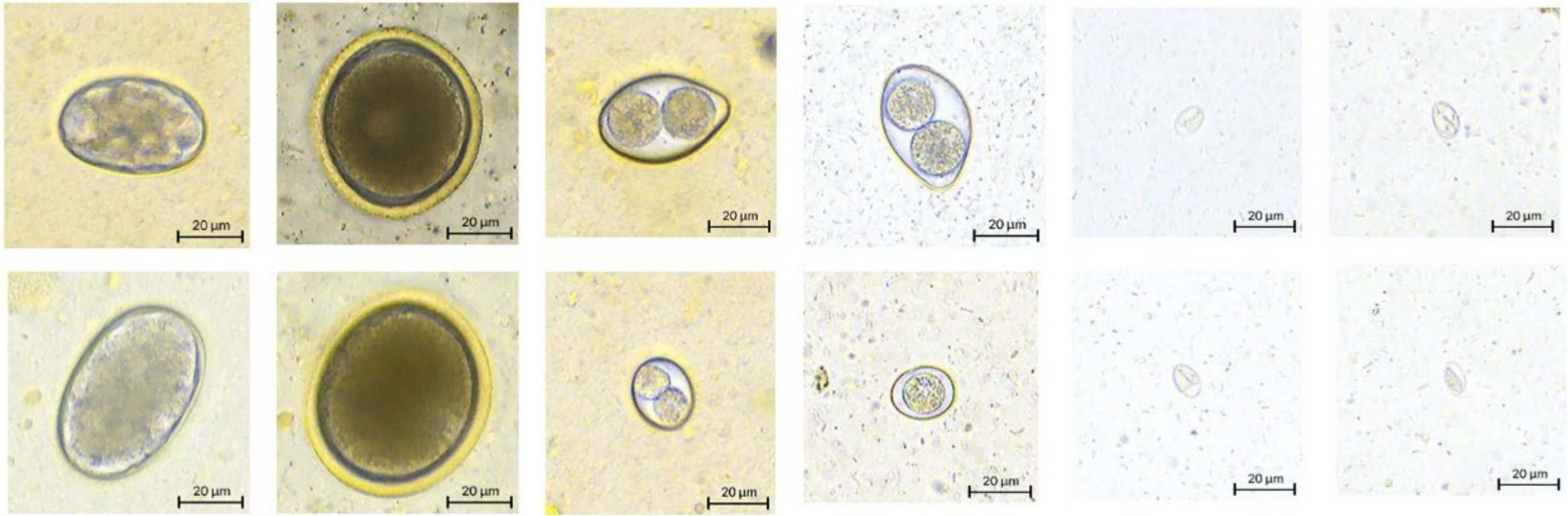
40x objective
(mag. 400x)

Giardia

Yeast

Zinc sulfate fecal flotation showing *Giardia* cysts and yeast

From: Further evaluation and validation of the VETSCAN IMAGYST: in-clinic feline and canine fecal parasite detection system integrated with a deep learning algorithm



† *C. felis* and *C. canis* (top); *C. rivolta* and *C. ohioensis* (bottom)
†† Intact *Giardia* cyst (top); Collapsed *Giardia* cyst (bottom)

Images of targeted parasites captured by the VETSCAN IMAGYST system

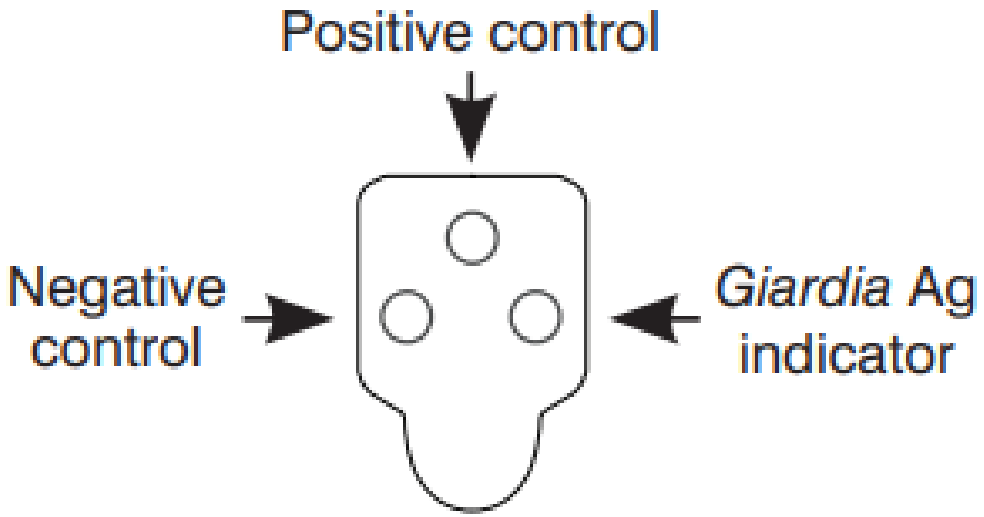
Diagnosis: Wet mount Giardia

T. blagburni
Spindle-shaped
Forward motility
Does NOT form cysts

Giardia
Petal shape
Falling leaf motility
Forms cysts

Antigen (cysts) detection kits, ELISA

Rapid in-house; ↑ Specificity and Sensitivity



detection of soluble *Giardia* antigen

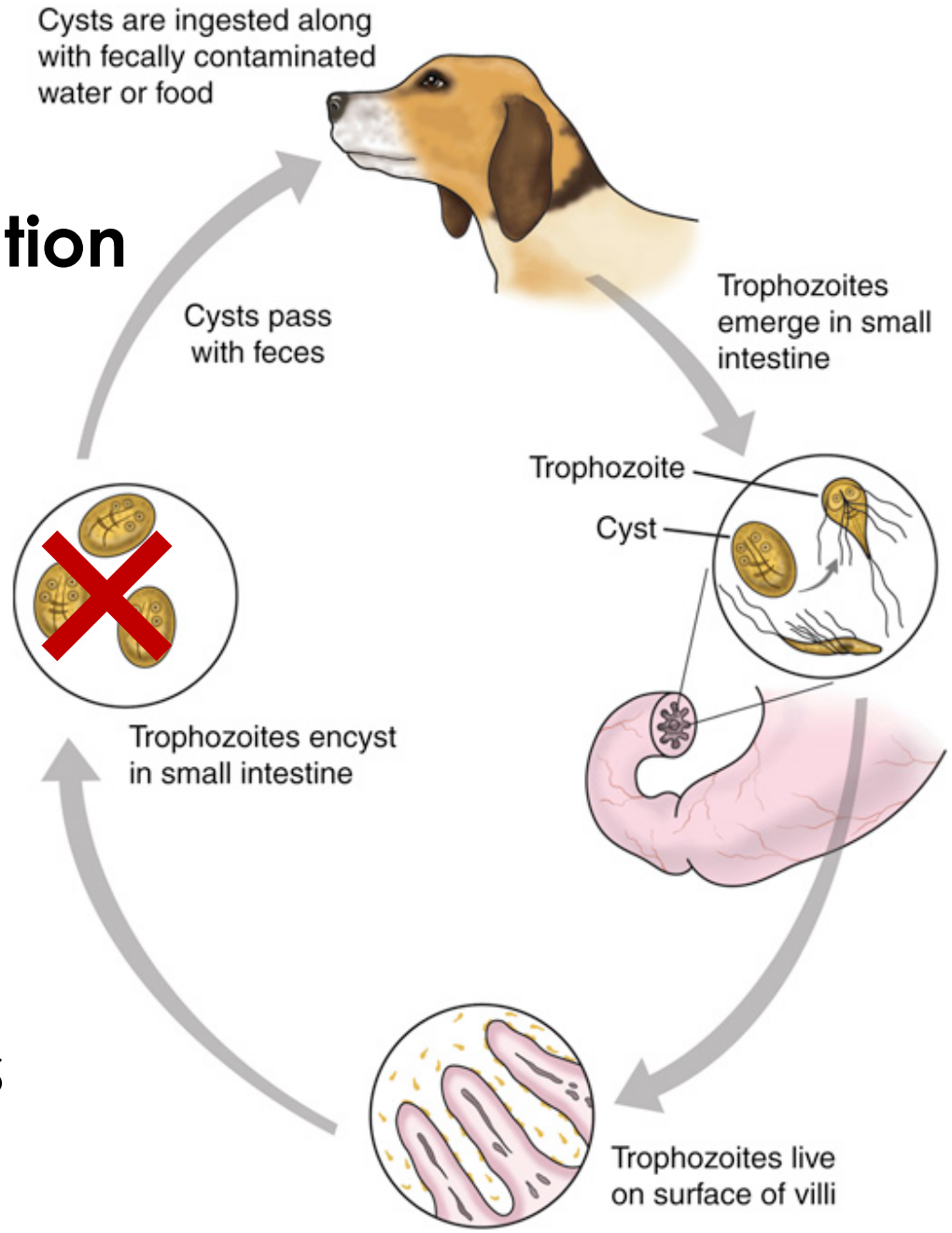
Treatment: *Giardia*
Goal is to resolve clinical signs

- Fenbendazole (Febantel) or Metronidazole
- Probiotics and fiber (psyllium)
- Treatment duration depends on drug but range 3-8 days
- **Follow-up with strict environmental decontamination, bathing the animal, etc. to prevent reinfection**.
- **Treat only symptomatic dogs & cats** to decrease development of resistance to antiprotozoal drugs.
- Some animals will persistently shed cysts despite treatment and resolution of clinical signs

Companion Animal Parasite Council (CAPC) for up-to-date management recommendations (https://capcvet.org/)

Control: *Giardia*

- **Strict prevention of fecal contamination**
- Outdoor environment
  -pick up, dispose of feces
- Indoor environments
  -**clean (soap/water)**
  -**disinfect**
  -dry out cysts
- Bathing contaminated fur
- *Giardia* cysts can survive for months



Epidemiology: *Giardia*

Risk Factors:

- **High density situations (catteries, kennels, shelters, dog parks)**
- **Younger animals**

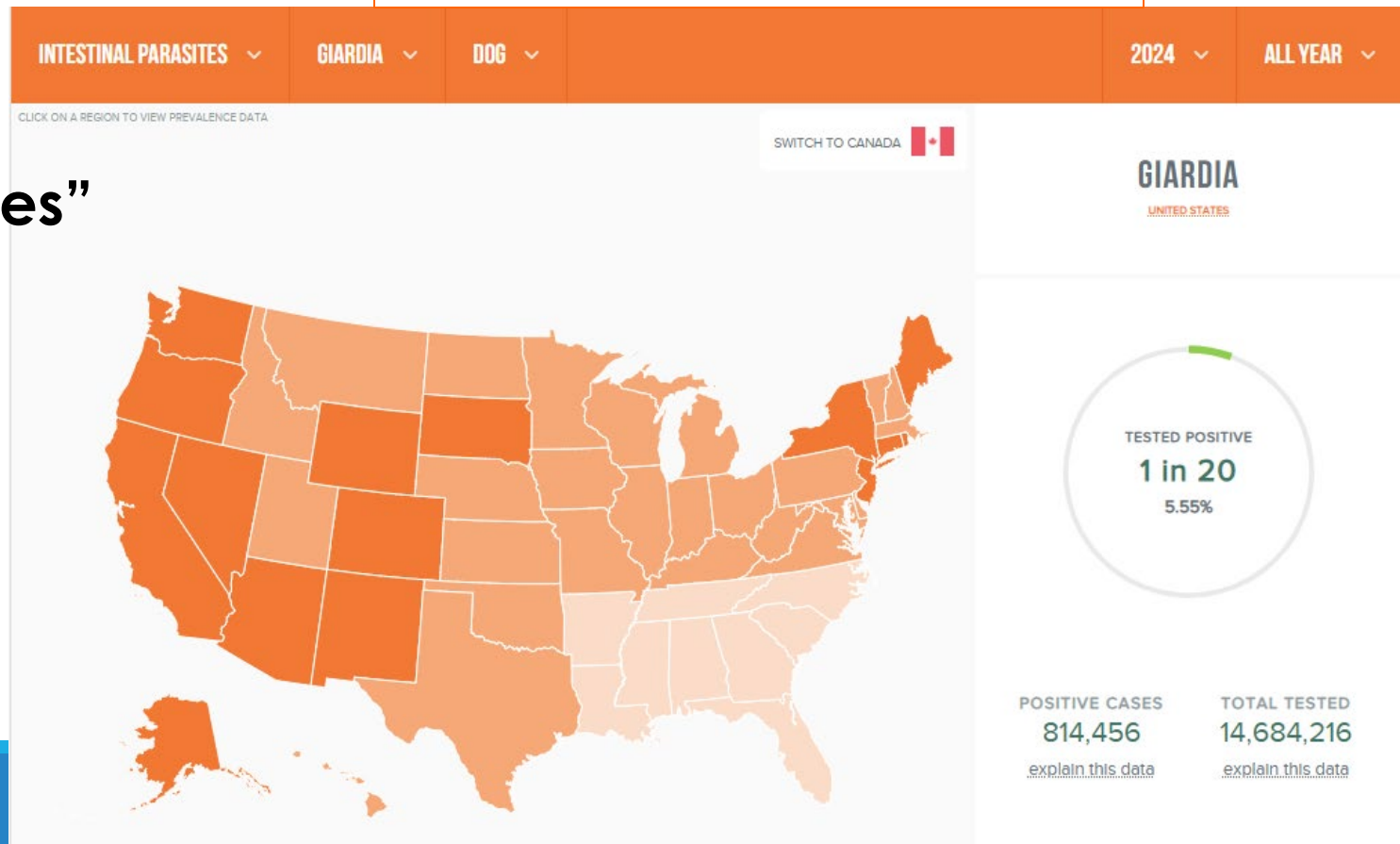
More likely to spread:

- **Btwn same species "house mates"**

Risk Factors for Refractory cases often due to:

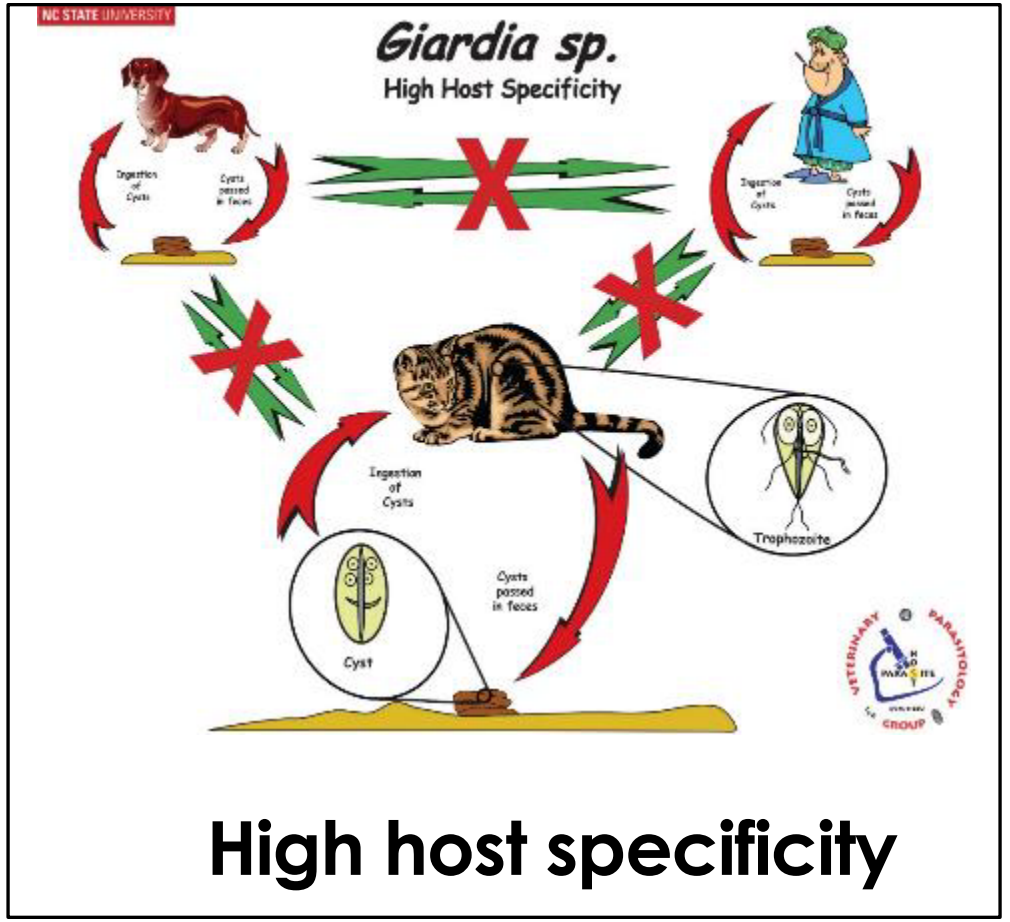
- **Reinfection**
- ***Giardia/Cryptosporidium***
- ***Giardia/Tritrichomonas***

FYI: Prevalence 2024 US
Dog: 5.55%
Cat: 4.43%



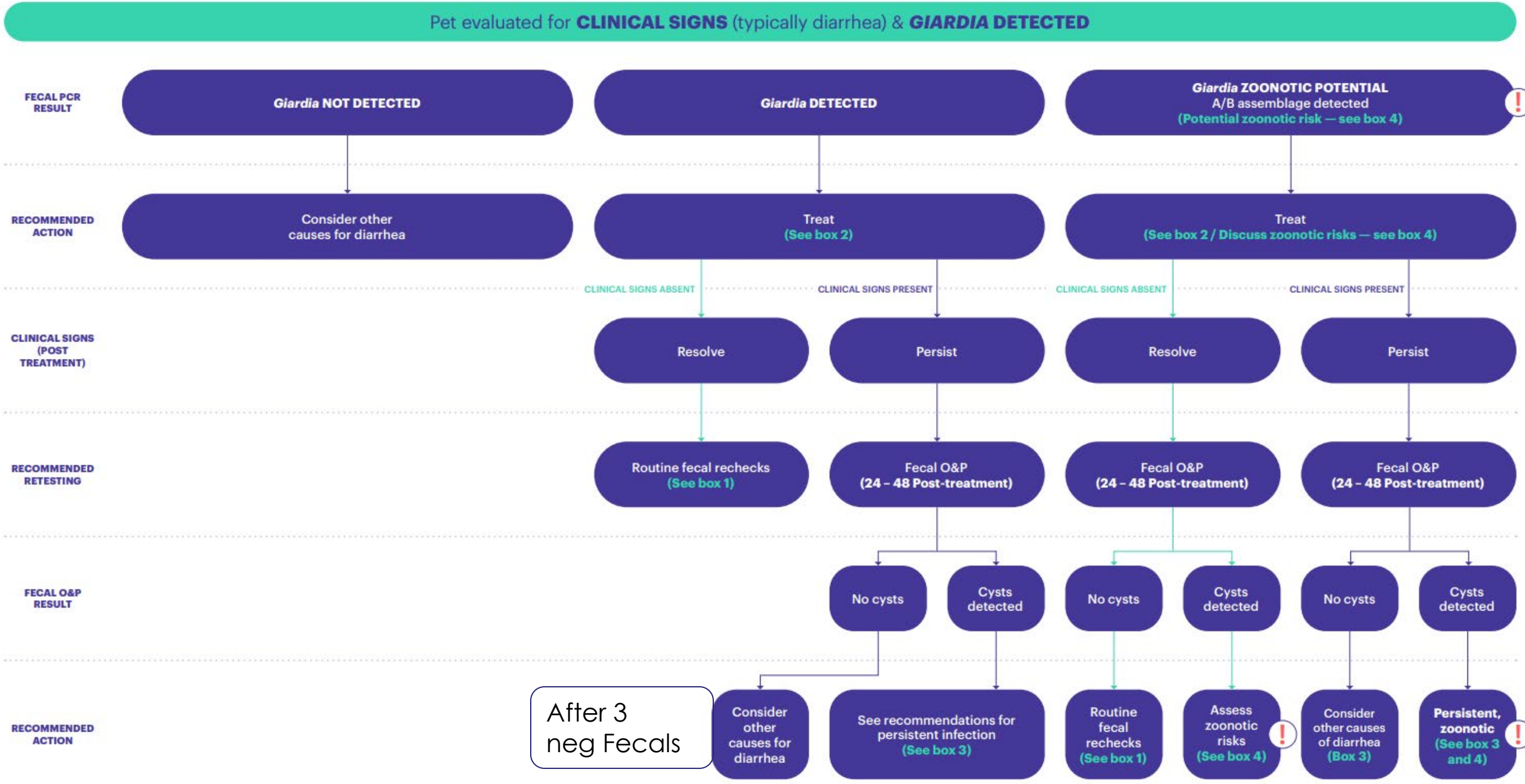
Zoonosis: *Giardia*

- *Giardia* spp. contain molecular assemblages (differences in the genome) A-H
- Most of the molecular assemblages seem to be host specific –**zoonosis rare**.
- **Concern for immunocompromised people**
  - Assemblage **A & B – Humans**
  - Assemblage C & D – Canines
  - Assemblage F – Felines

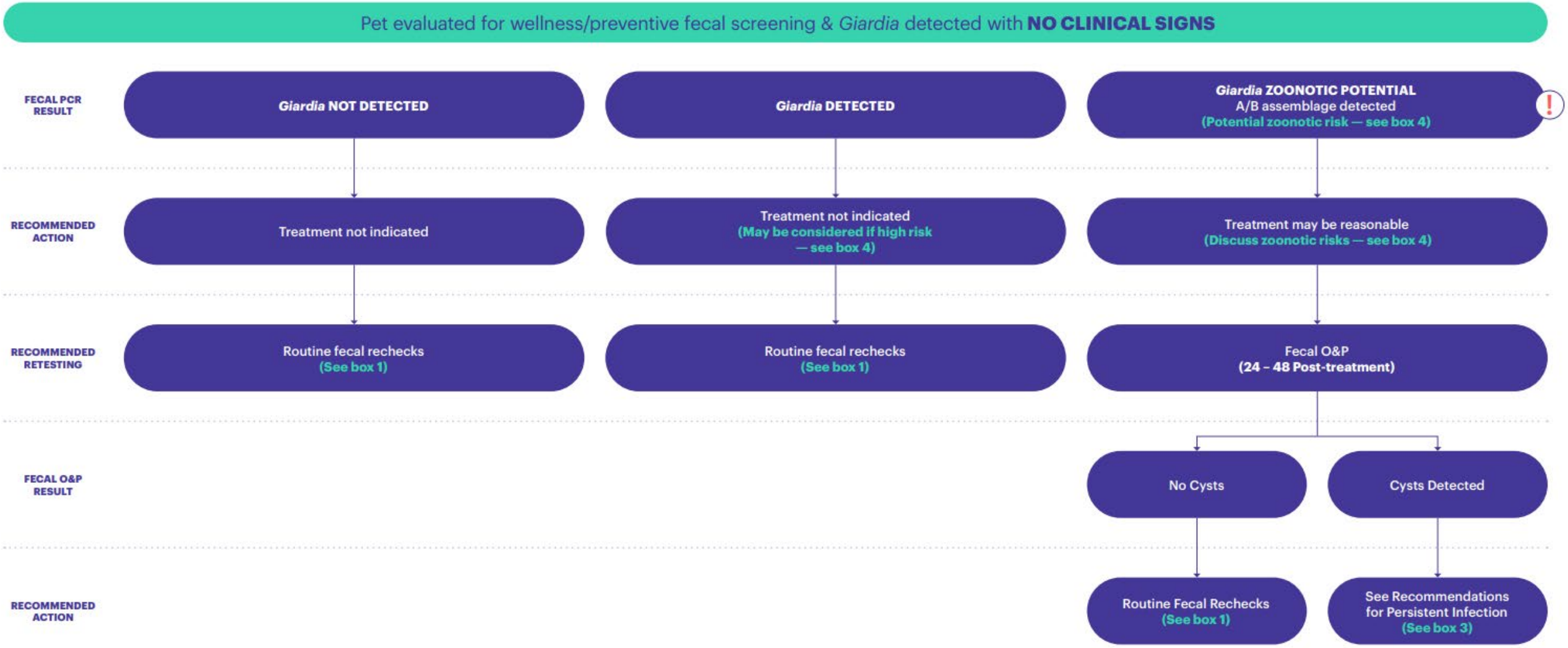


High host specificity

FYI: Antech KeyScreen PCR Algorithms



PCR for routine GI parasite detection?? Not so sure about that



FYI: this algorithm

FYI: Antech KeyScreen PCR Algorithms

CLINICAL DECISION-MAKING *GIARDIA*

Pet signalment, history (clinical, treatment), test results, risk, and pet-owner specific factors will inform individual case treatment decisions. Consideration should be given to appropriate antimicrobial use/stewardship and One Health.

1 FECAL TESTING

The KeyScreen® GI Parasite PCR panel detects 20 GI parasites and markers for zoonotic potential *Giardia* and hookworm treatment resistance. It can be used for routine monitoring/screening and for patients with clinical signs, e.g., diarrhea.

Routine endoparasite monitoring (wellness/ screening):

- The Companion Animal Parasite Council (CAPC) recommends fecal testing 4 times/year in the first year of life and twice/year for adult pets.
- The Canadian Parasitology Expert Panel (CPEP) recommends fecal testing twice/year in the first six months of life, and 1 to 2 times/year for dogs over 6 months. Risk factors (Box #4) may impact (increase) advised testing frequency.

Retesting for *Giardia*:

- At 24 to 48 hours, after completion of appropriate treatment of *Giardia* (Box 2), fecal testing by centrifugal flotation (O&P) can be used to evaluate for persistent shedding of *Giardia* cysts.
- Note, PCR is highly sensitive, some pets may continue to detect positive during this timeframe.

2 MANAGEMENT/TREATMENT

Treatment goal:

Improvement of clinical signs (diarrhea)

Pharmaceutical treatment:

Drug and other treatment recommendations: capcvet.org/guidelines/*giardia*

Non-pharmaceutical treatment:

- Supportive care
- Dietary management (higher-fiber, probiotics)
- Bathing of patient to remove infectious cysts from hair coat, perineum
- Picking up feces immediately to reduce environmental contamination
- Cleaning of environment
- Disinfection if possible/practical

3 PERSISTENT *GIARDIA*

Pets may have persistent clinical signs or infection (despite appropriate treatment) due to:

- An alternate underlying disease as a cause of (or contributor to) clinical signs, e.g., chronic enteropathy or neoplasia
- Co-infection with another pathogen
- Environmental re-infection
- Compliance concerns, e.g., medication, dosing, duration
- Immunosuppression
- Drug resistance

To help rule out environmental re-infection, re-testing (centrifugal fecal flotation, O&P) at 24-48 hours post-treatment (Box 1) can be considered.

Repeating treatment for patients with clinical signs and persistent cysts detected can be considered.

4 RISK ASSESSMENT ZOONOTIC POTENTIAL

Management is guided by individual pet risk factors, including contact with or exposure to:

- Young children, the elderly, immunocompromised, or pregnant individuals
- Other household pets
- Highly contaminated environments, e.g., kennels, dog parks etc.
- Environments shared with wildlife

Additional risk assessment resources at CPEP: research-groups.usask.ca/cpep

Zoonotic potential *Giardia*:

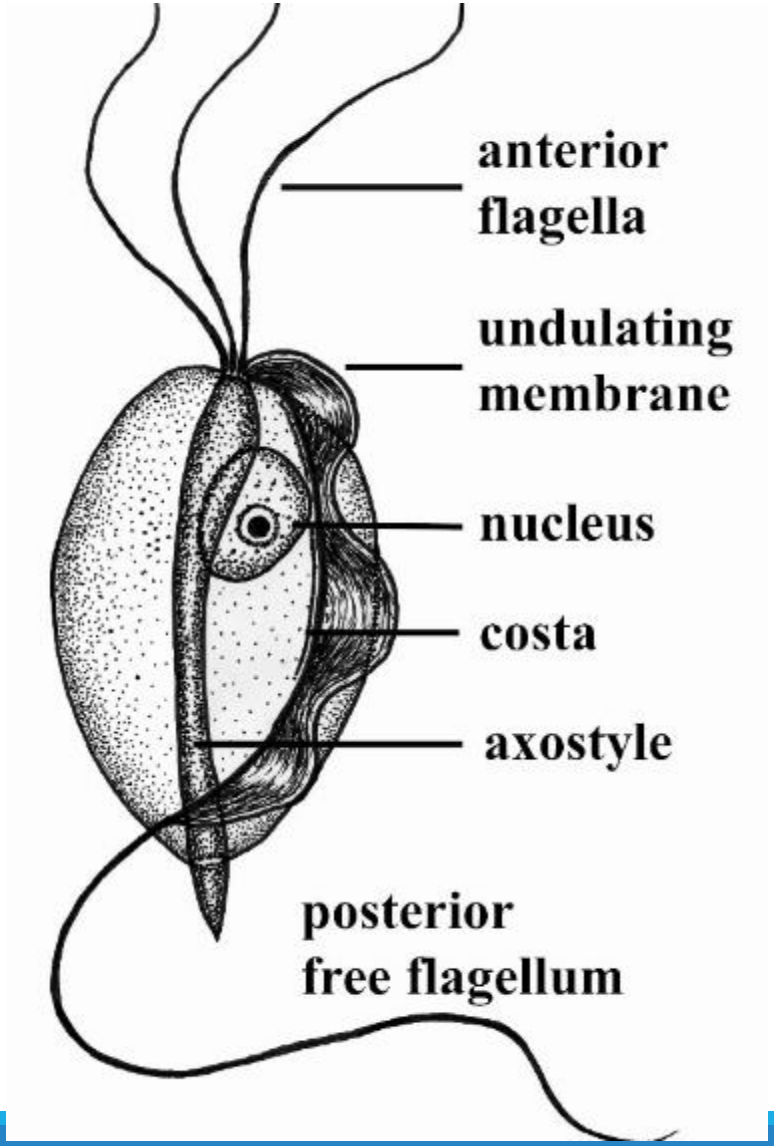
- If zoonotic potential *Giardia* (A or B assemblage) is detected, pet-owners should be informed of potential zoonotic risks.
- If the A or B assemblage is not detected, pet-owners can be assured that zoonotic risk is low.

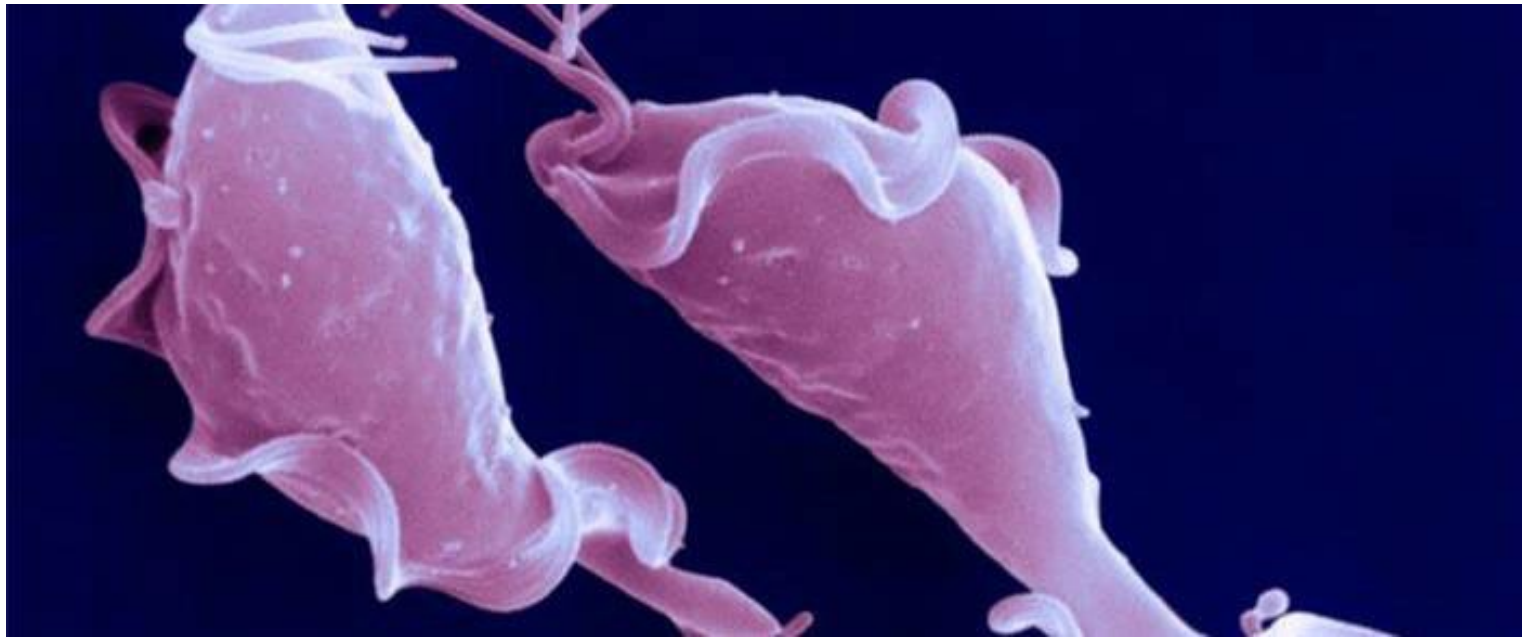
Take Home Points: *Giardia*

1. Direct Life Cycle
2. Causes damage to the small intestines
3. Small bowel diarrhea
4. Dx by fecal, direct, ELISA or PCR
5. Only treat symptomatic animals
6. Disinfection important (cysts resistant)
7. Risk factors are young, high density
8. Refractory cases can be challenging, consider reinfection and co-infections

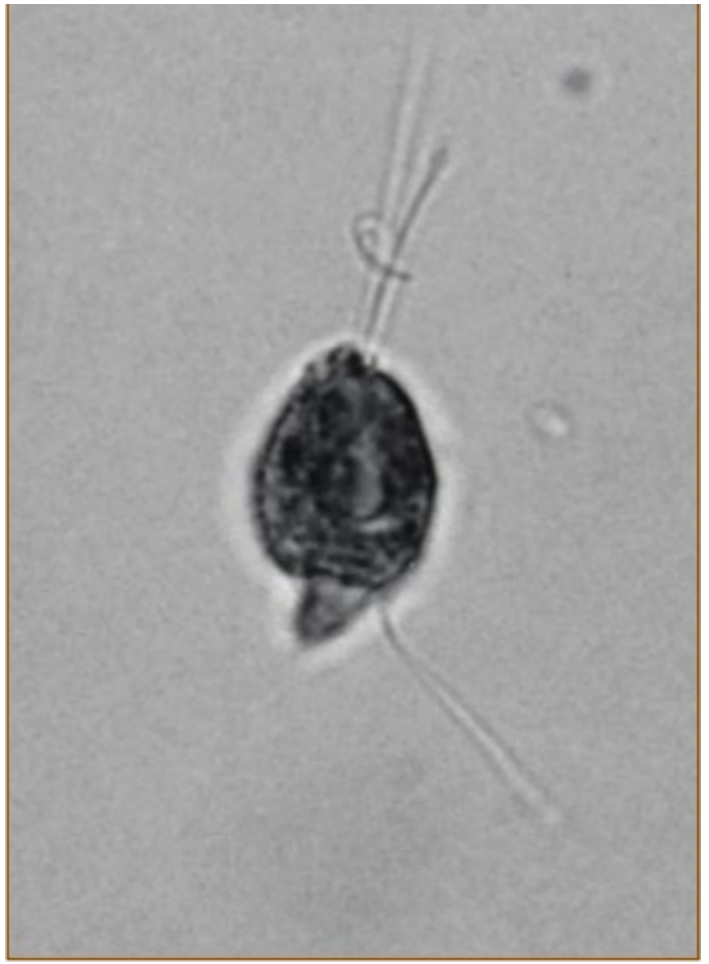
Know the difference between *Giardia* and *T. blagburni*

Tritrichomonas spp.





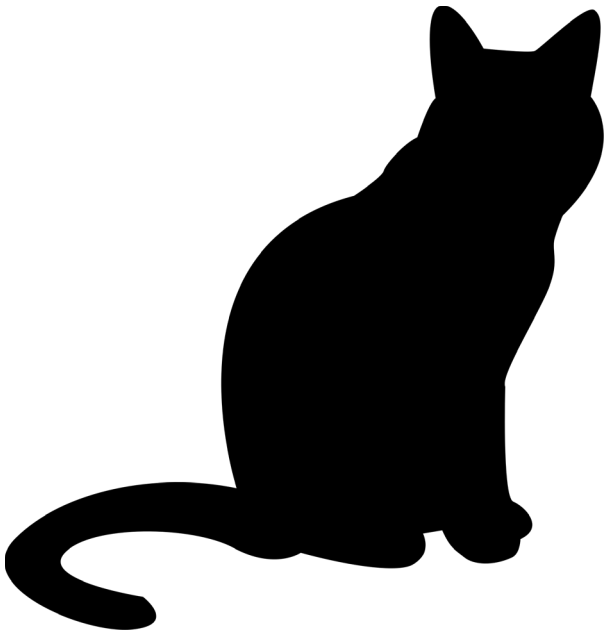
Tritrichomonas blagburni



Feline Tritrichomoniosis

A cause of persistent Large Bowel Diarrhea in Cats

Learning Objectives: *Tritrichomonas blagburni*

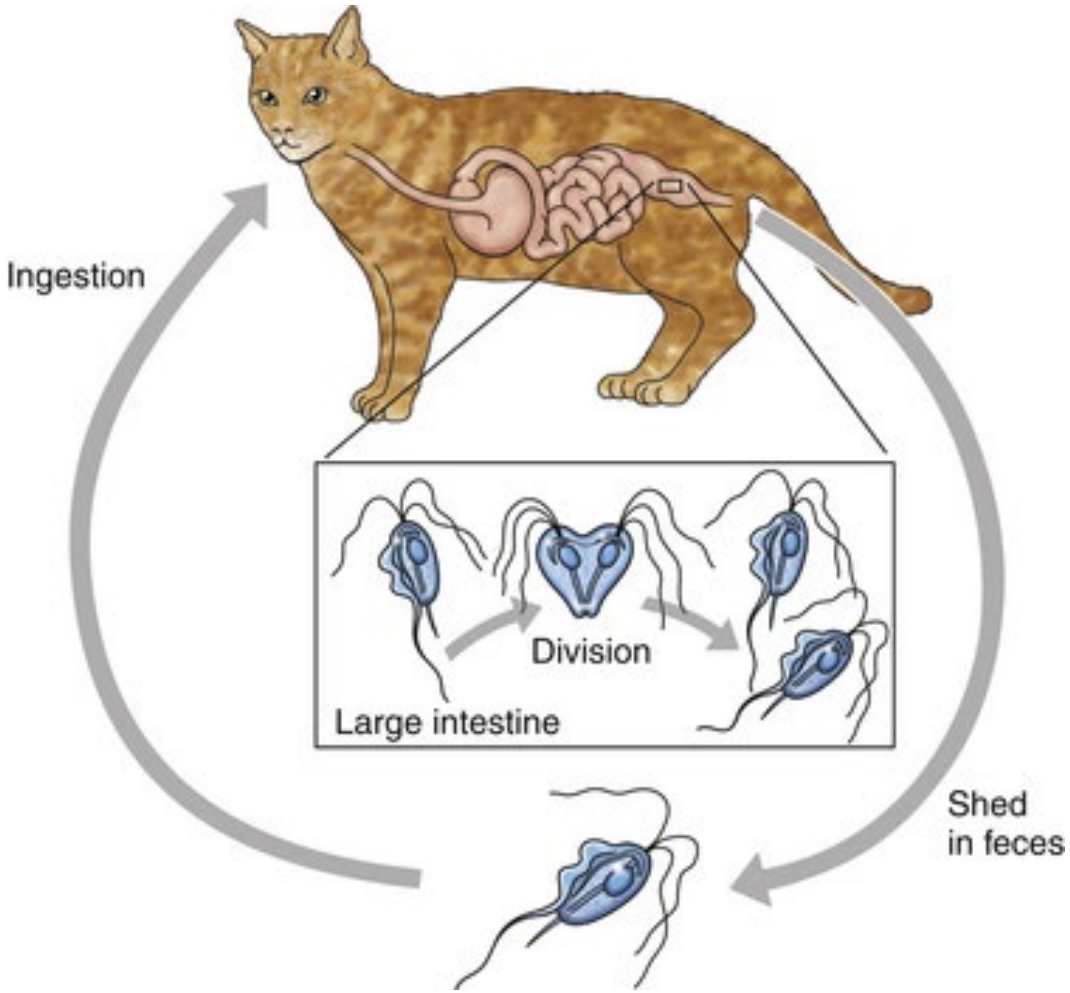


1. Life cycle: understand the specified life cycle details.
2. Transmission: understand how it is transmitted.
3. Pathogenesis: understand how it causes disease.
4. Clinical signs: recognize the main clinical signs in cats.
5. Diagnosis: understand the 3 specific methods for diagnosing.
6. Treatment: understand how to treat *T. blagburni*.
7. Control: understand how to control this infection and how it is different from controlling *Giardia*
8. Epidemiology: recognize risk factors for infection

FYI = no test questions

Life Cycle: *T. blagburni*

Direct Life Cycle



Primary Host

1. cats, large bowel

Transmission

1. Fecal-oral –ingest trophozoites

Stages

1. Trophozoite
2. No cyst stage (why is this important?)

Reproduction

1. binary fission in feline GI tract

https://veteriankey.com/trichomoniasis/

Pathology: *T. blagburni*

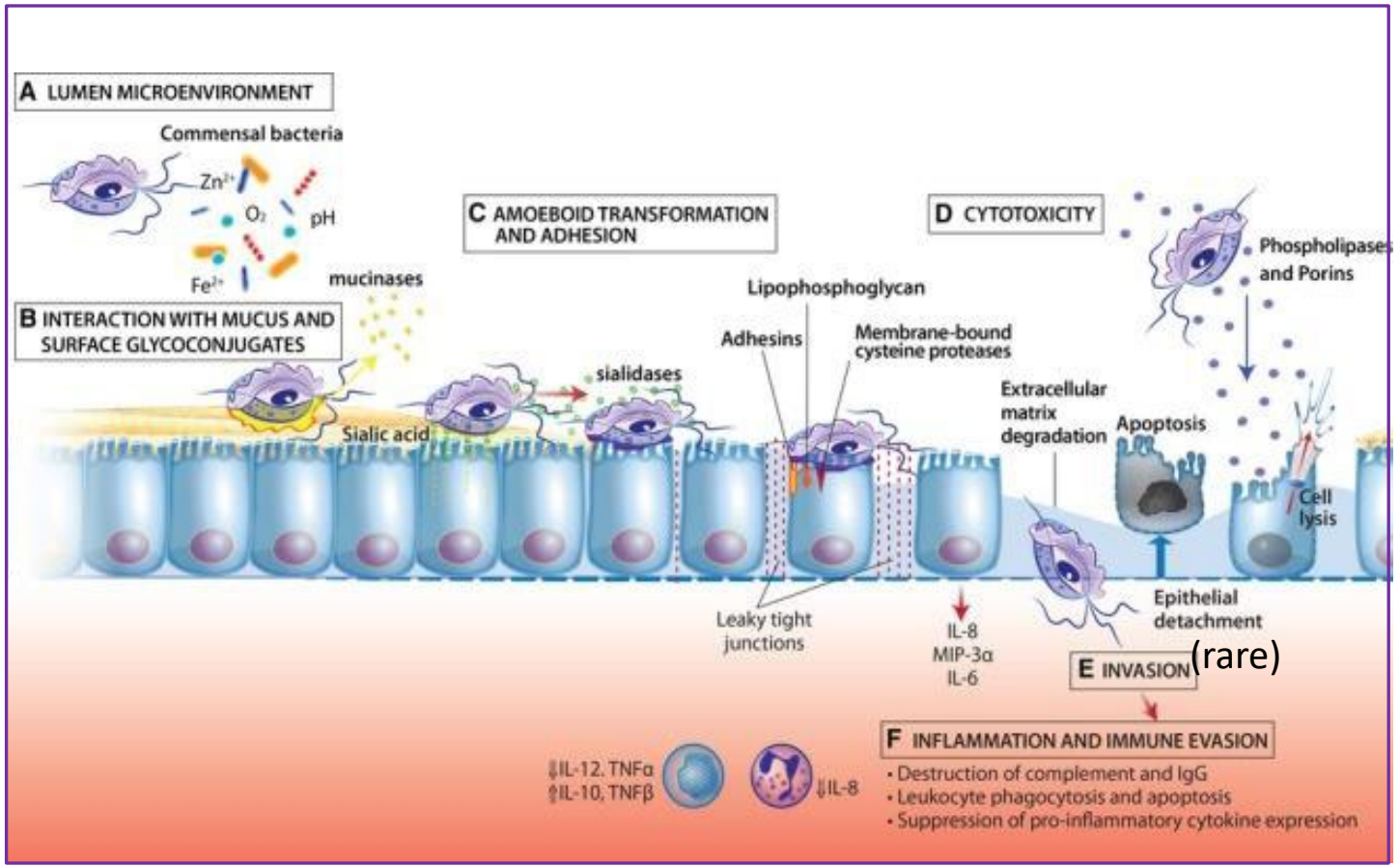
<u>Indirect tissue destruction of large intestines causes colitis and diarrhea</u>

-extracellular (does not infect enterocytes)

-cytotoxic effect when interacting with the surfaces of host cells

-dysbiosis of host microbiota

Theorized pathogenic mechanisms of *T. blagburni*



FYI: this illustration

Clinical Disease: *Tritrichomonas blagurni*

1. Diarrhea: waxing and waning, chronic

2. Semi-formed to "cow-pie" diarrhea
   +/- mucus; +/- fresh blood

3. Usually feces in hair around anus (messy rear)

4. Urgency and straining (tenesmus)

- Usually, no other clinical signs
- Worse in kittens and younger cats
- Some cats are subclinical

Clinical Disease: *Tritrichomonas blagburni*

messy rear

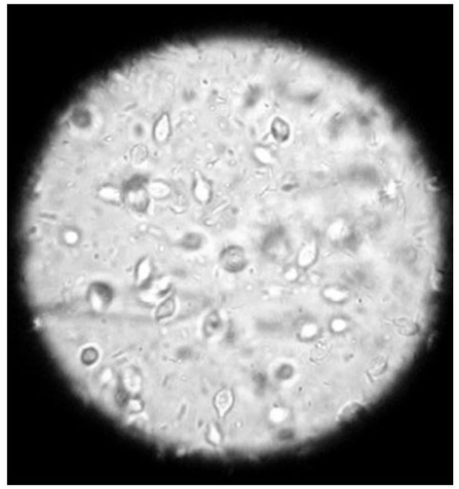
frequent dribbling

fresh blood or mucus

NOT typically melena

Semi-formed to cow-pie

Diagnosis: *Tritrichomonas blagburni*

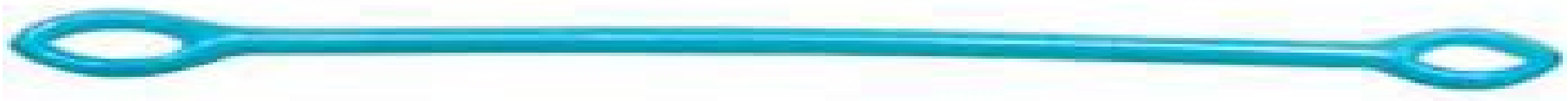


1. **Fresh wet-mounts and light microscopy**
   to view motile trophozoites
   - don't confuse with *Giardia*
   - low sensitivity (≤14%)

2. ***In-vitro* culture kit** (InPouch TF Feline for culturing)
   - perform in clinic; use with wet mount

3. **PCR**: *Tritrichomonas* Diagnostic Lab at NC State
   https://cvm.ncsu.edu/research/labs/clinical-sciences/tfoetus/#tabsPnl1-tab-1
   - Fecal sample (pathogen dead or alive)
   - high sensitivity

Diagnosis: PCR *Tritrichomonas blagburni*



Fecal loop increased sensitivity for *T. blagburni* PCR

Samples should be diarrheic (i.e. formed stool less sensitive)

FYI

- Fecal samples collected via fecal loop had significant **increased probability of positive PCR**
- Maybe fecal loop promotes **collection of samples from the surface of the colonic mucosa** where the trichomonads are found to adhere to the mucus and epithelial lining

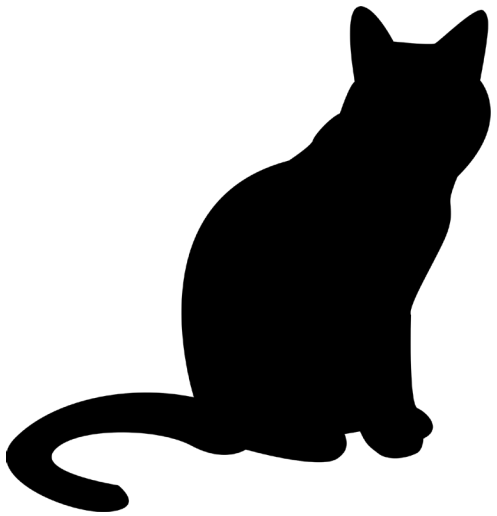
Hedgespeth, Barry A., et al. "Association of fecal sample collection technique and treatment history with *Tritrichomonas foetus (blagburni)* polymerase chain reaction test results in 1717 cats." *Journal of veterinary internal medicine* 34.2 (2020): 734-741.

Diagnosis: **Wet Mount** *Tritrichomonas blagburni*

T. blagburni
Spindle-shaped
Forward motility

Giardia
Petal shape
Falling leaf motility

Treatment: *Tritrichomonas blagburni*



Ronidazole {*Tricho Plus*}

- FYI: 30 mg/kg every 12 or 24 hrs for 14 days
- Be alert for neurotoxicity (narrow safety margin)
- Resistant populations increasing

Enterococci-containing probiotics and fiber?

Diarrhea may resolve without treatment ~ 9 months

Unresponsive to metronidazole

1. Gookin, Jody L., et al. "Efficacy of ronidazole for treatment of feline Tritrichomonas foetus infection." *Journal of veterinary internal medicine* 20.3 (2006): 536-543.
2. Dickson, Rachel, et al. "The effect of enterococci on feline Tritrichomonas foetus infection in vitro." *Veterinary parasitology* 273 (2019): 90-96.

Control: *Tritrichomonas blagburni*

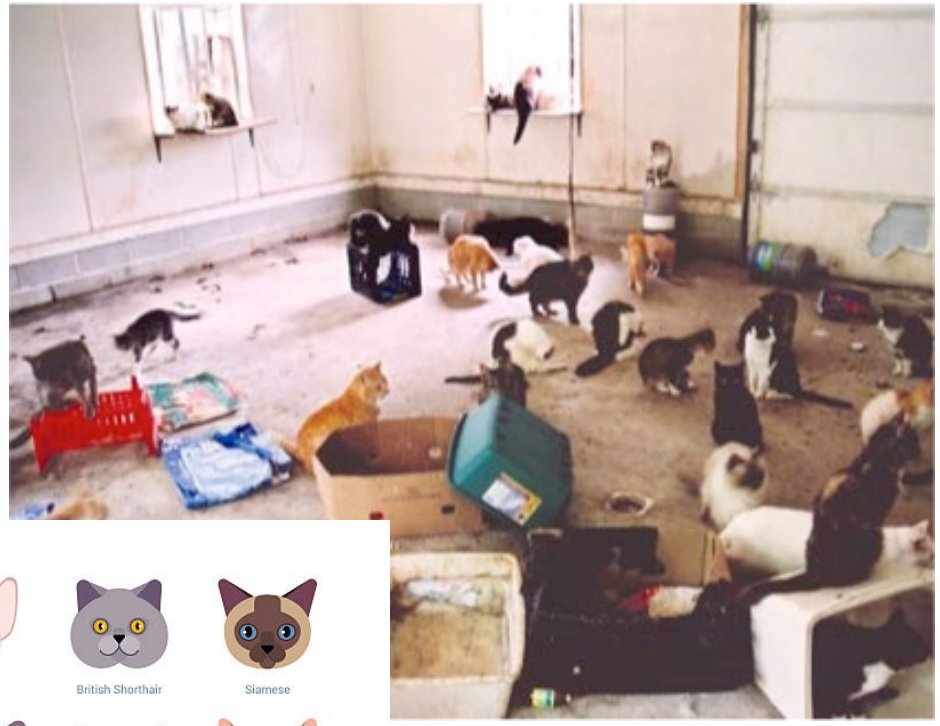
- **Strict hygiene** in group housing, cattery, shelter, and cat shows.

- **There is no cyst form** (exists only as a trophozoite), so the organism does not persist for more than a few hours in **dry, aerobic environments**

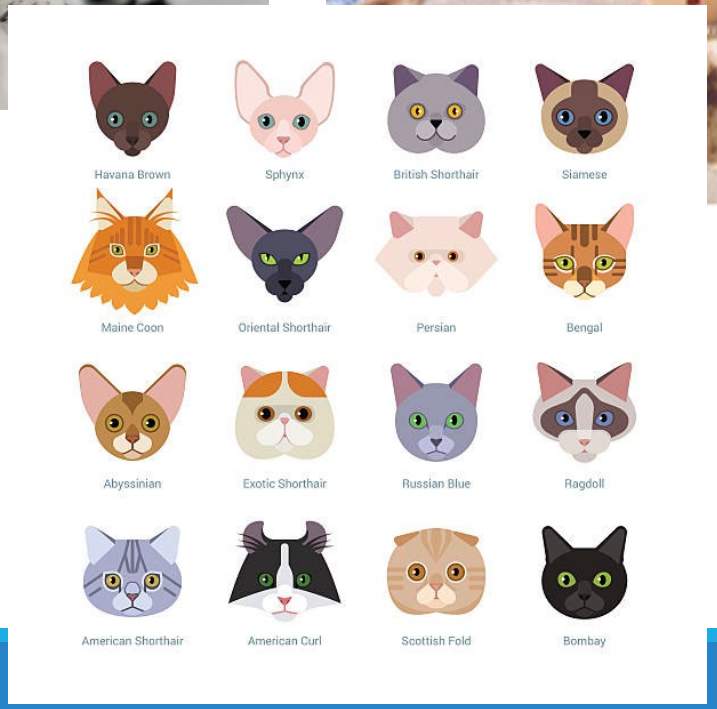
- It can survive for several days in feces and 1 day in water or urine

Epidemiology: *Tritrichomonas blagburni*

Risk Factors:



1. **Young cats**
   Older cats may be asymptomatic



2. **Cats from high density populations, PUREBRED CATS!**

   (FYI: Abyssinian, Bengal, and Siamese cats most common in the US based on some studies)

Occurs worldwide

Not zoonotic

Take Home Points: *Tritrichomonas blagburni*

1. Direct Life Cycle (cat-to-cat)
2. Causes damage to the large intestines
3. Large bowel diarrhea
4. Dx PCR or direct
5. Ronidazole only treatment
6. Risk factors are young, high density and purebreds

Know the difference between *Giardia* and *T. blagburni*

In-Class Discussion

their cat's

A cat owner is complaining because of apparent fecal incontinence.

What are some additional questions you might ask?

Infectious differentials?

Diagnostics?

Cross species or Zoonosis ?

In-Class Discussion

3-year-old Labrador Retriever has repeatedly tested positive for giardia cysts in a fecal despite a course of fenbendazole. Waxing and waning diarrhea persists.

What are some additional questions you might ask the owner?

What would you recommend for this dog?

Zoonosis?

Have Questions?

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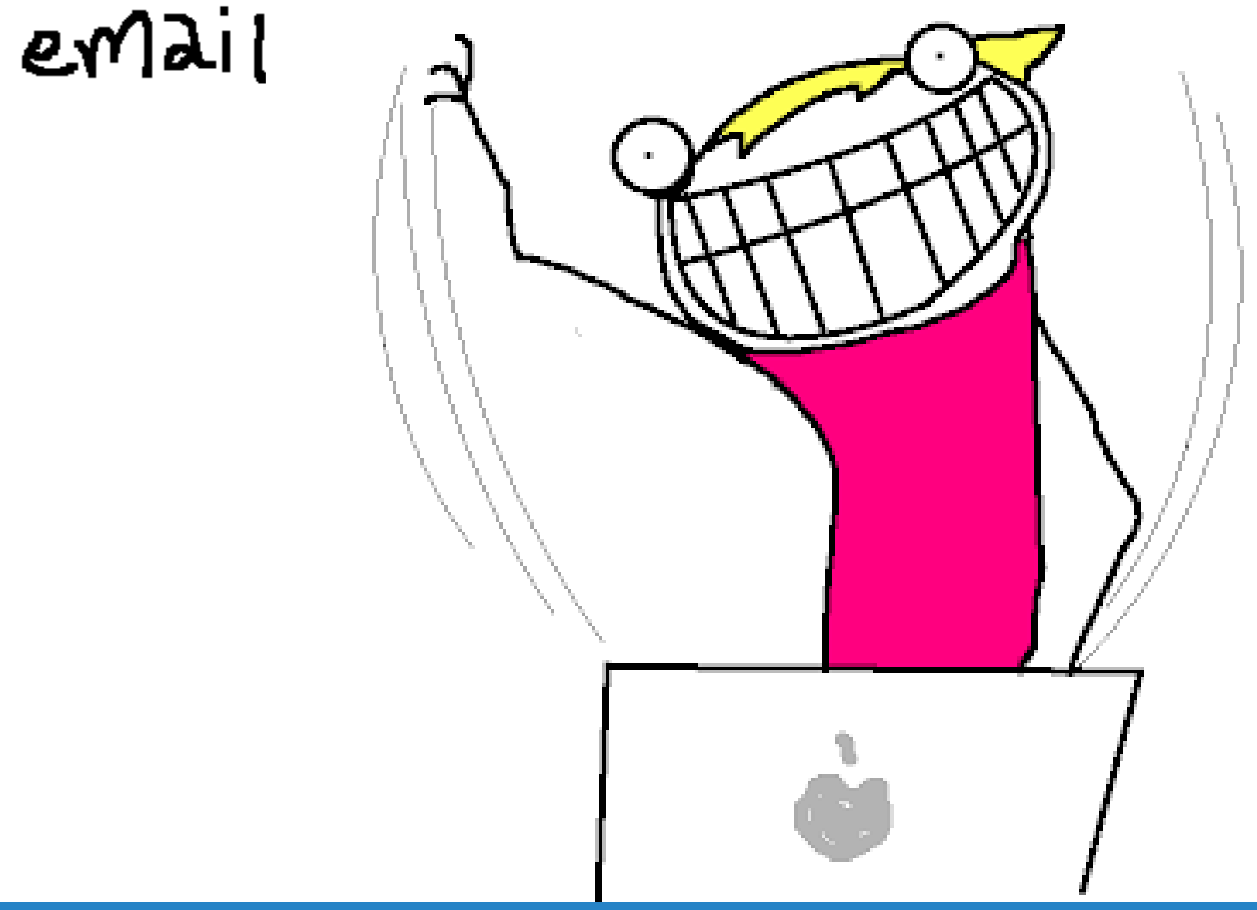

Illustration by Allie Brosh, http://hyperboleandahalf.blogspot.com/