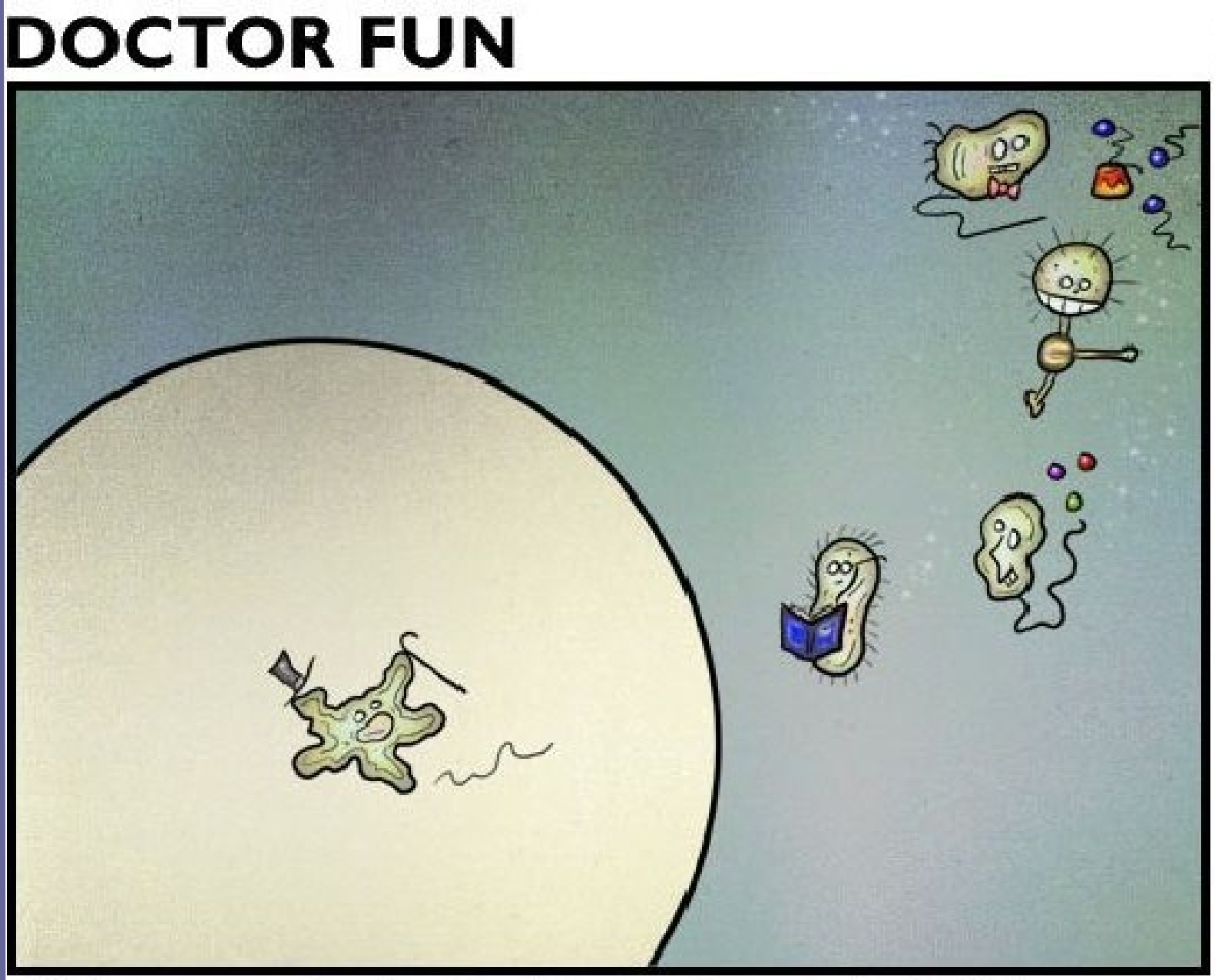
Introduction to Parasitic Protozoa

Barbara Qurollo
Associate Research Professor
Dept. Clinical Sciences
baquroll@ncsu.edu



All the protozoa lined up for their one chance in the big light on open slide night.

Learning Objectives

1. **Learn basic characteristics of protozoa**

(free-living, motile, eukaryotes, where most are non-pathogenic)

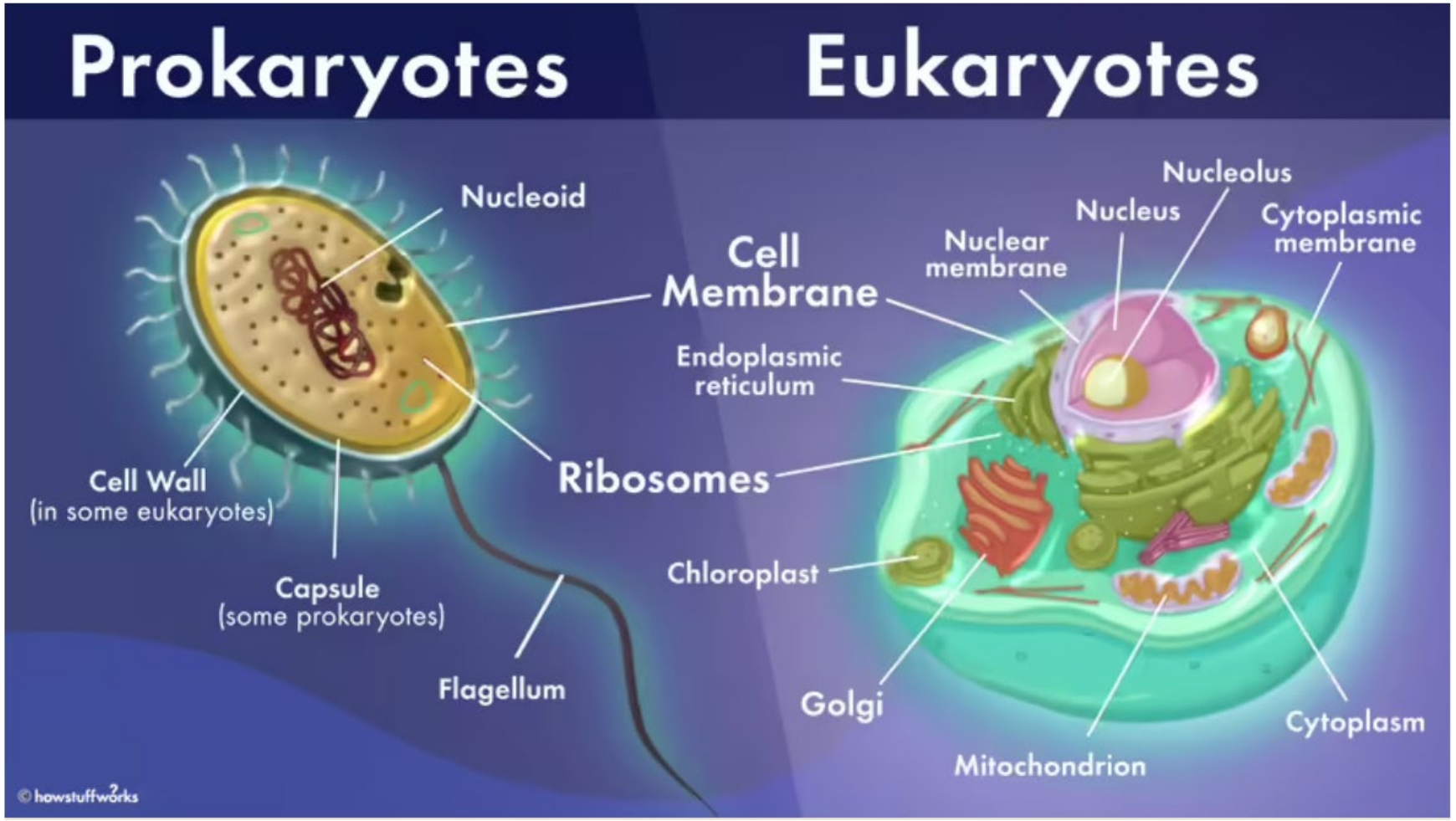
1. **Understand parasitic protozoa life cycle strategies and the types of hosts that can be infected**

2. **Understand how knowing a protozoa life cycle will help you practice veterinary medicine**

3. **Understand the 4 general mechanisms that allow parasitic protozoa to cause disease in animal hosts (pathogenesis) and recognize them in specific examples**

Protozoa are single-celled eukaryotes

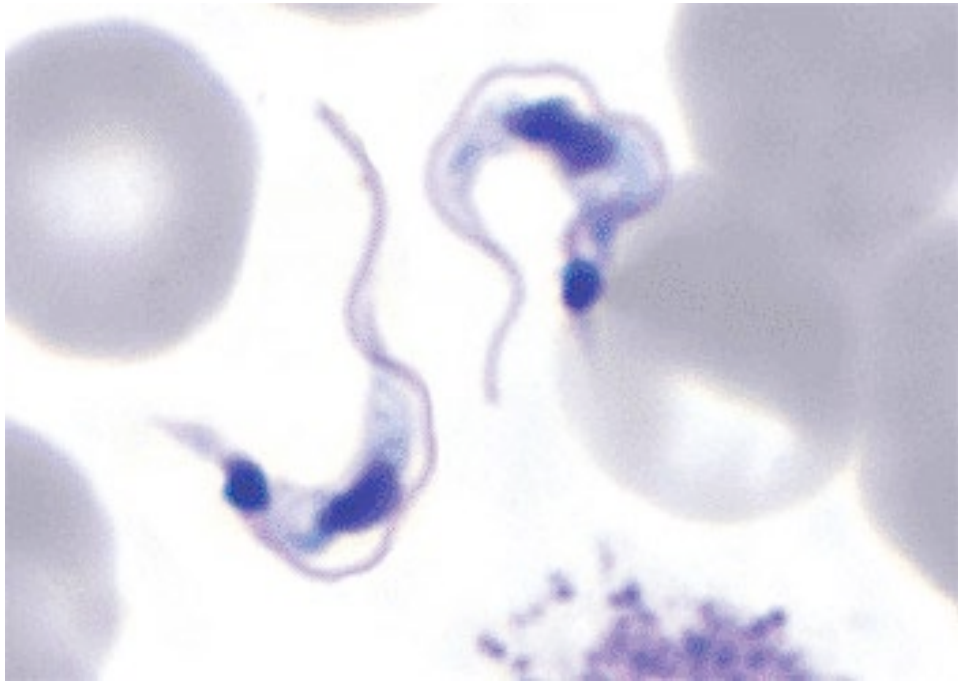
bacteria



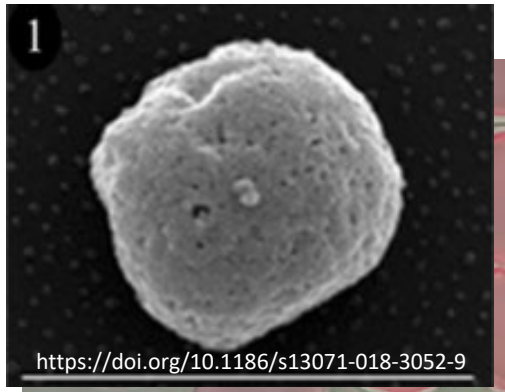
protozoa
fungi
plants
animals

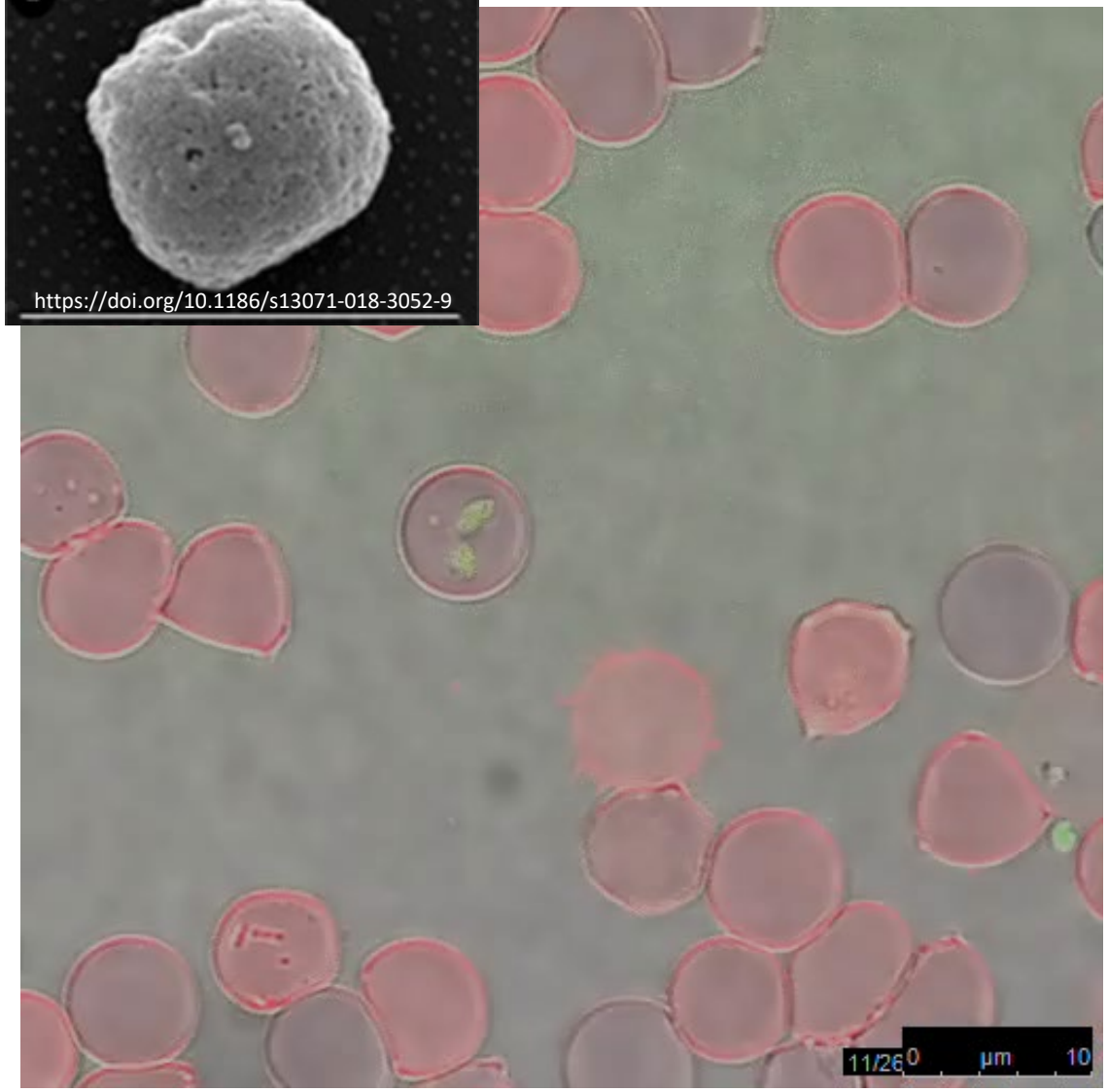
Protozoa

- Most are free-living
- Some are parasitic
  - some are medically important



All protozoa are motile

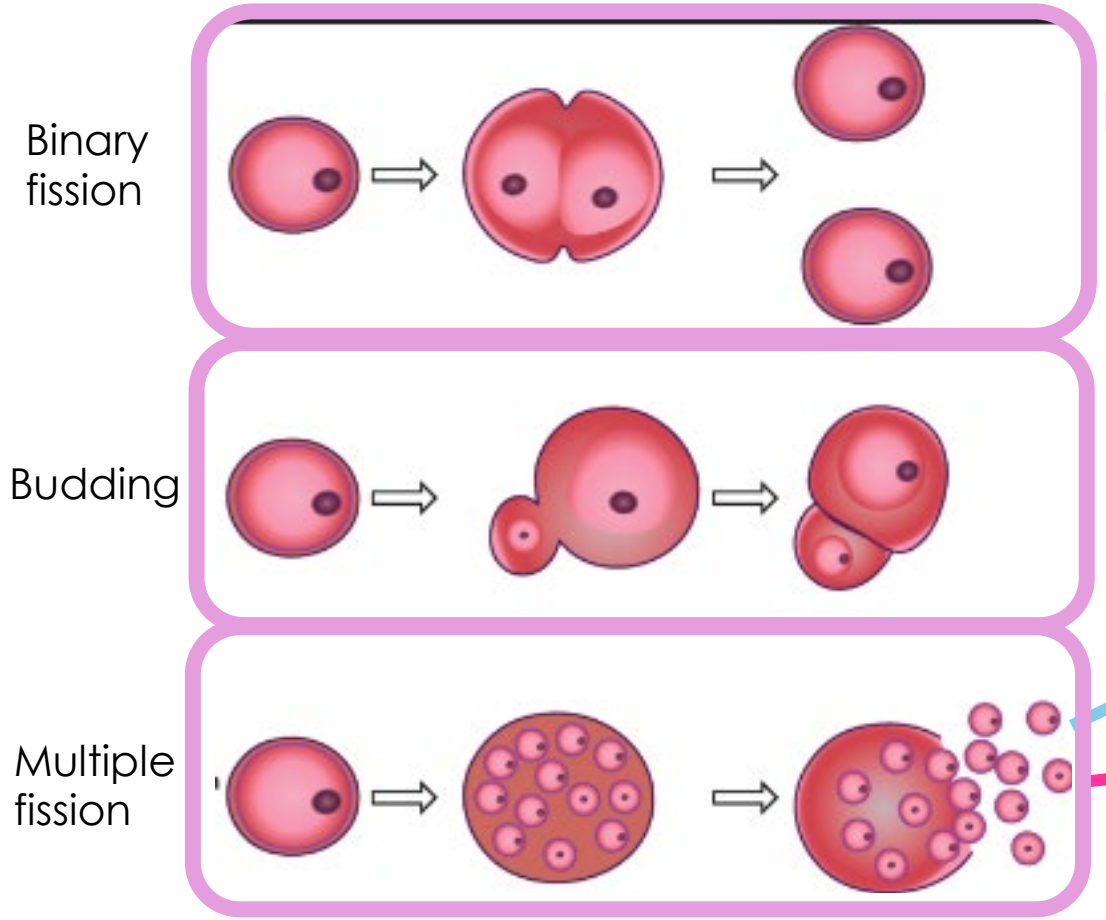




Protozoa Reproduction

Asexual

-binary or multiple fission, budding
-create many organisms quickly = damage to host cells



coccidia

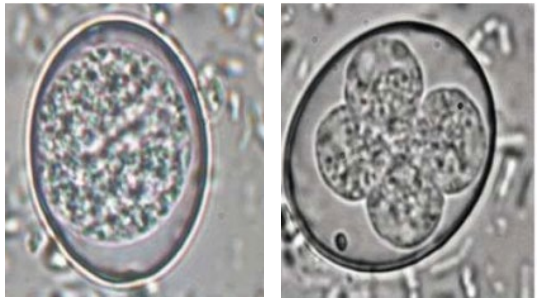
Sexual

(Apicomplexa protozoa)

Microgamete (male)

Macrogamete (female)

Infective cells



Parasitic Protozoa

Symbionts = 2 organisms that live in close association with each other

Parasite = a symbiont that is dependent on host organism(s), often causing harm to the host(s)

Parasitic Protozoa

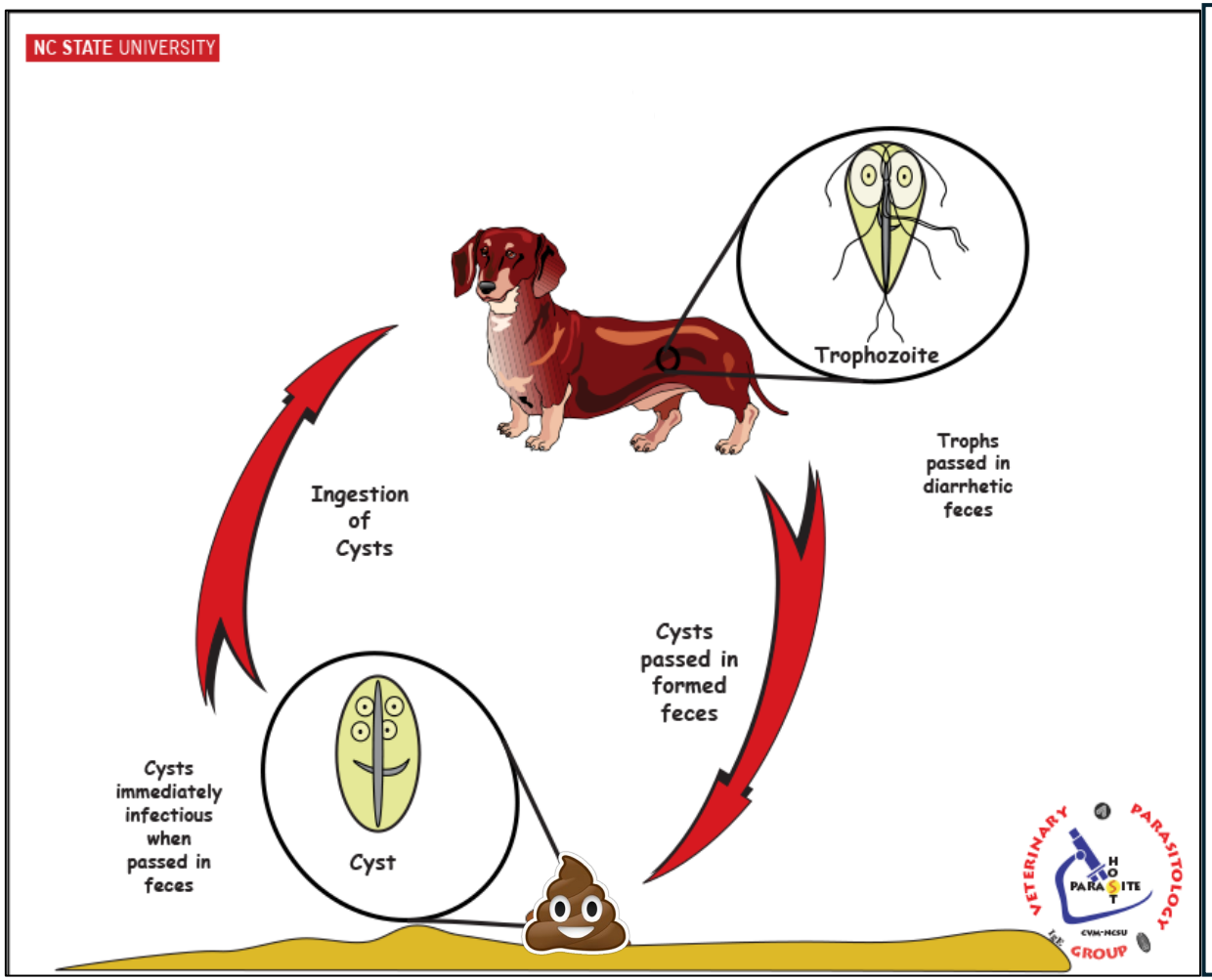
Life-cycle (infect hosts, reproduce)

Pathology (mechanisms that cause disease in the host)

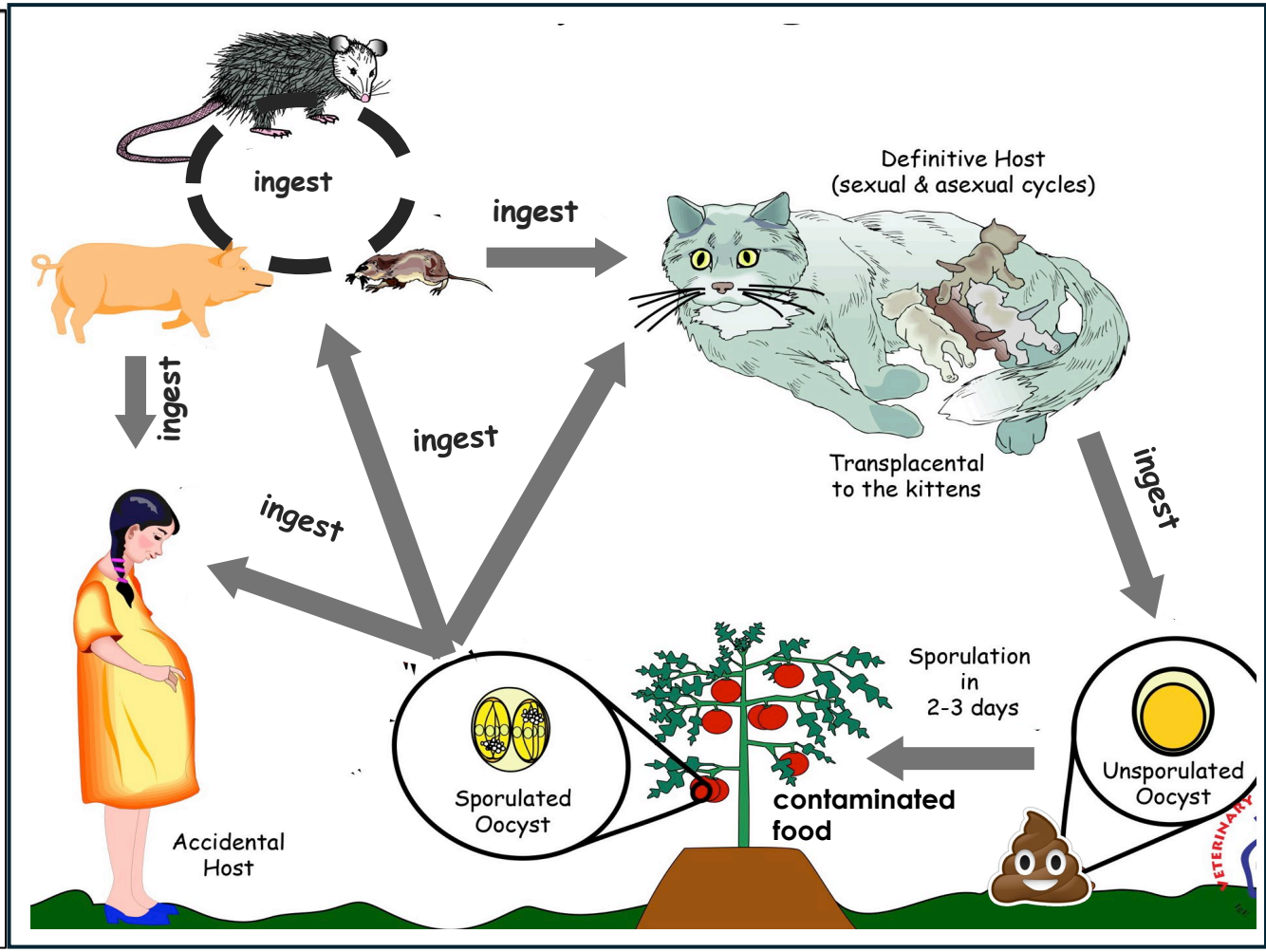
- cellular damage and molecular changes

Parasitic Protozoa Life-Cycles

Giardia



Toxoplasma gondii



Protozoa Life Cycle Strategies

- Direct life cycle – requires only a single host species
- Indirect life cycle – requires a second host (intermediate host)
- Facultative, indirect life cycle – can use a second host (intermediate host), but not required

- Transmission to new hosts – route (i.e. ingestion), infectious immediately vs. time to develop in the environment

- Stage of protozoa – exist in different forms in life-cycles based on timing and host
  e.g. Cysts (resistant in environment); Trophozoite (growing); Tachyzoite (fast growing)

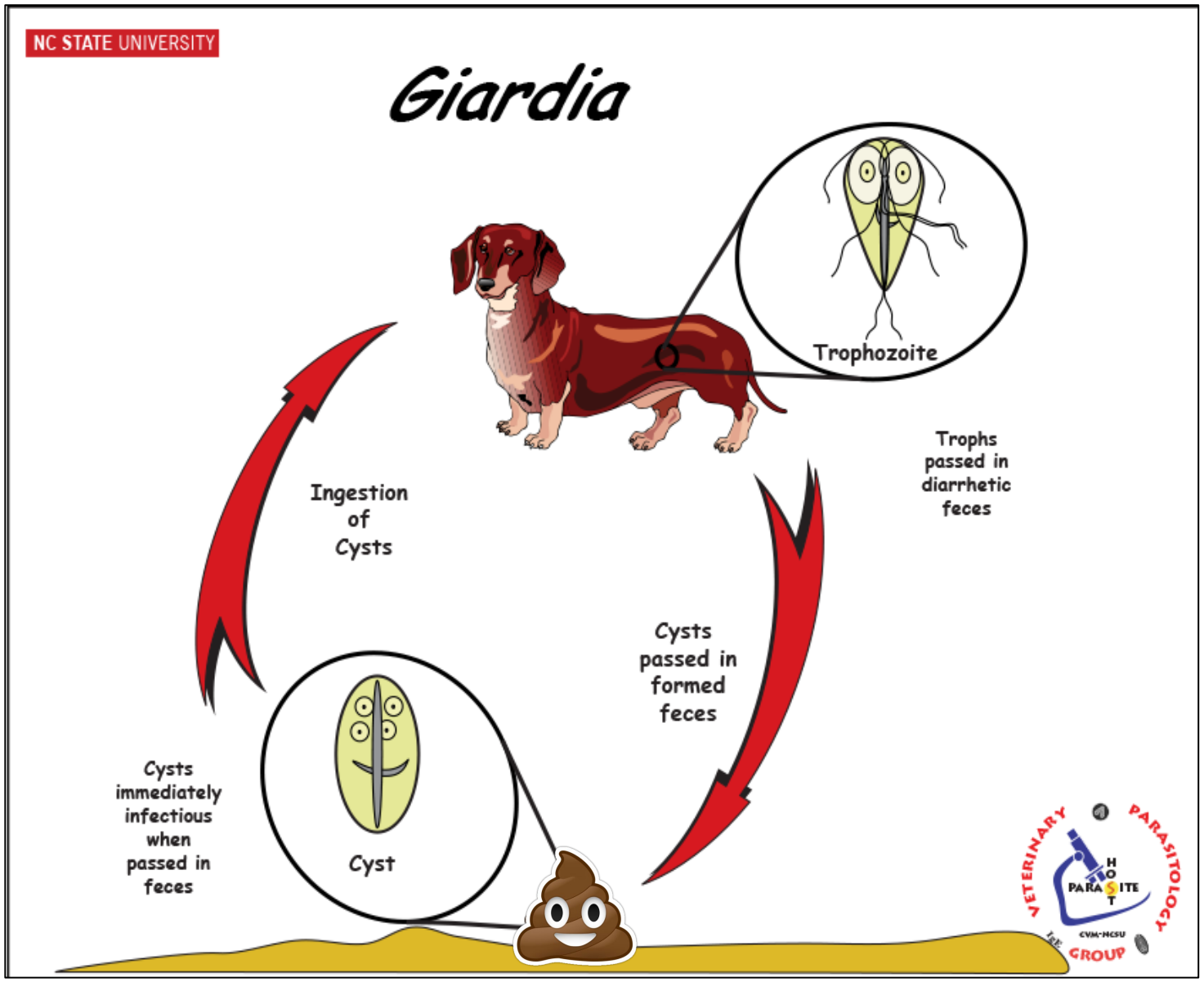
- Reproduction
  - Sexual stage occurs only in one host (definitive host) but not others
  - Asexual stages occur in all host types

- Host Specificity – High vs. Low

Host Types

- Definitive hosts – in multihost life-cycles, supports protozoa asexual and **sexual** reproduction
- Intermediate hosts – supports asexual multiplication, carrying parasites through food chains to the definitive host; they ***are*** required for indirect life-cycles
- Facultative Intermediate (AKA -Paratenic) hosts) – supports asexual multiplication, carrying parasites through food chains to the definitive host; they are ***NOT*** required to complete a life-cycle
- Accidental/Aberrant/Dead-end host – supports asexual multiplication, but the protozoa usually **won't complete its life-cycle** in this host

Life-Cycles Examples



Direct or Indirect?

Immediately infectious after passed?

What are the different stages of Giardia?

Toxoplasma gondii

Direct or Indirect?

Direct

Indirect (facultative)

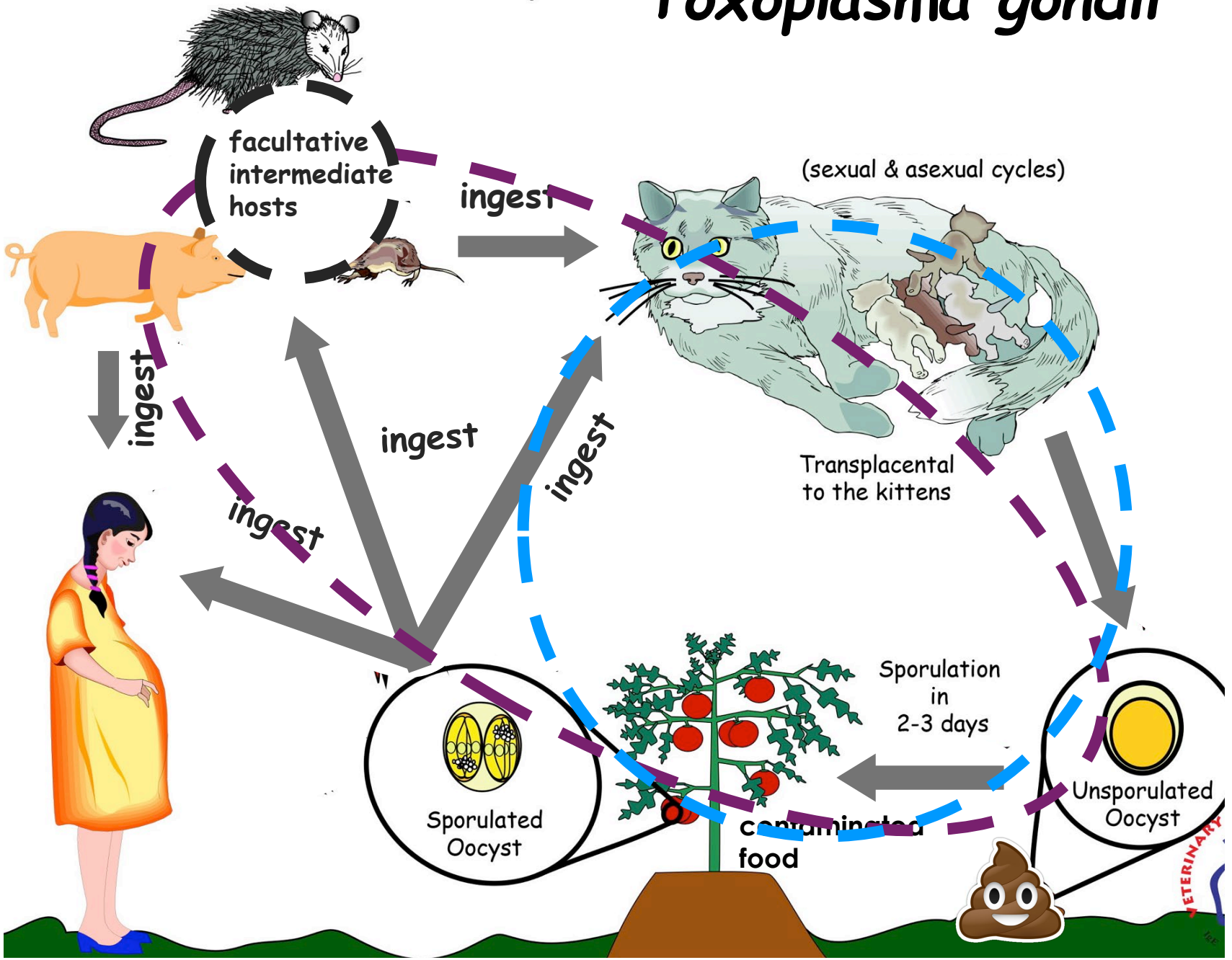
Immediately infectious after passed?

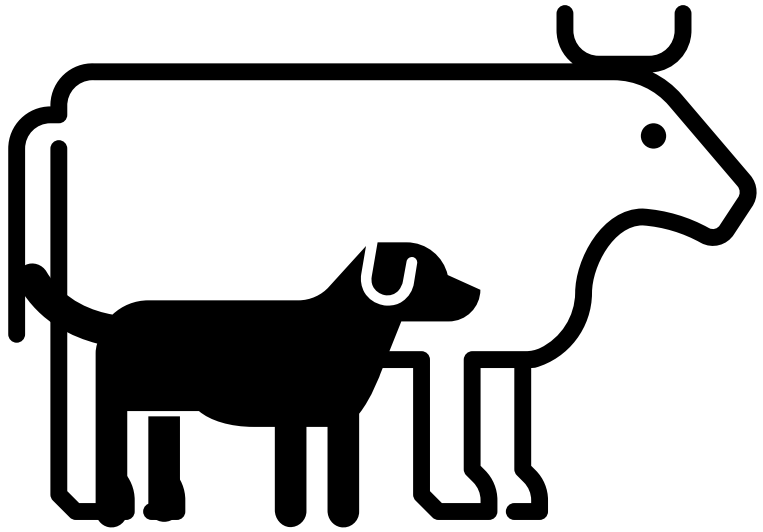
Name 3 different types of hosts.

Definitive host (cat)

Facultative intermediate (pig, opossum)

Accidental host (human)





As a veterinarian, why do you need to know life-cycles?

Control Disease by intervening and breaking the cycle

Diagnose by understanding if patients have been exposed to hosts (intermediate/vectors)

Educate clients, prevent zoonosis

Treatment know what stages are susceptible to treatment

Protozoa Pathogenesis

(mechanisms that cause disease)

We will focus on 4 primary mechanisms protozoa use

1. Direct destruction
2. Indirect destruction
3. Immunomodulation
4. Excretion of toxins

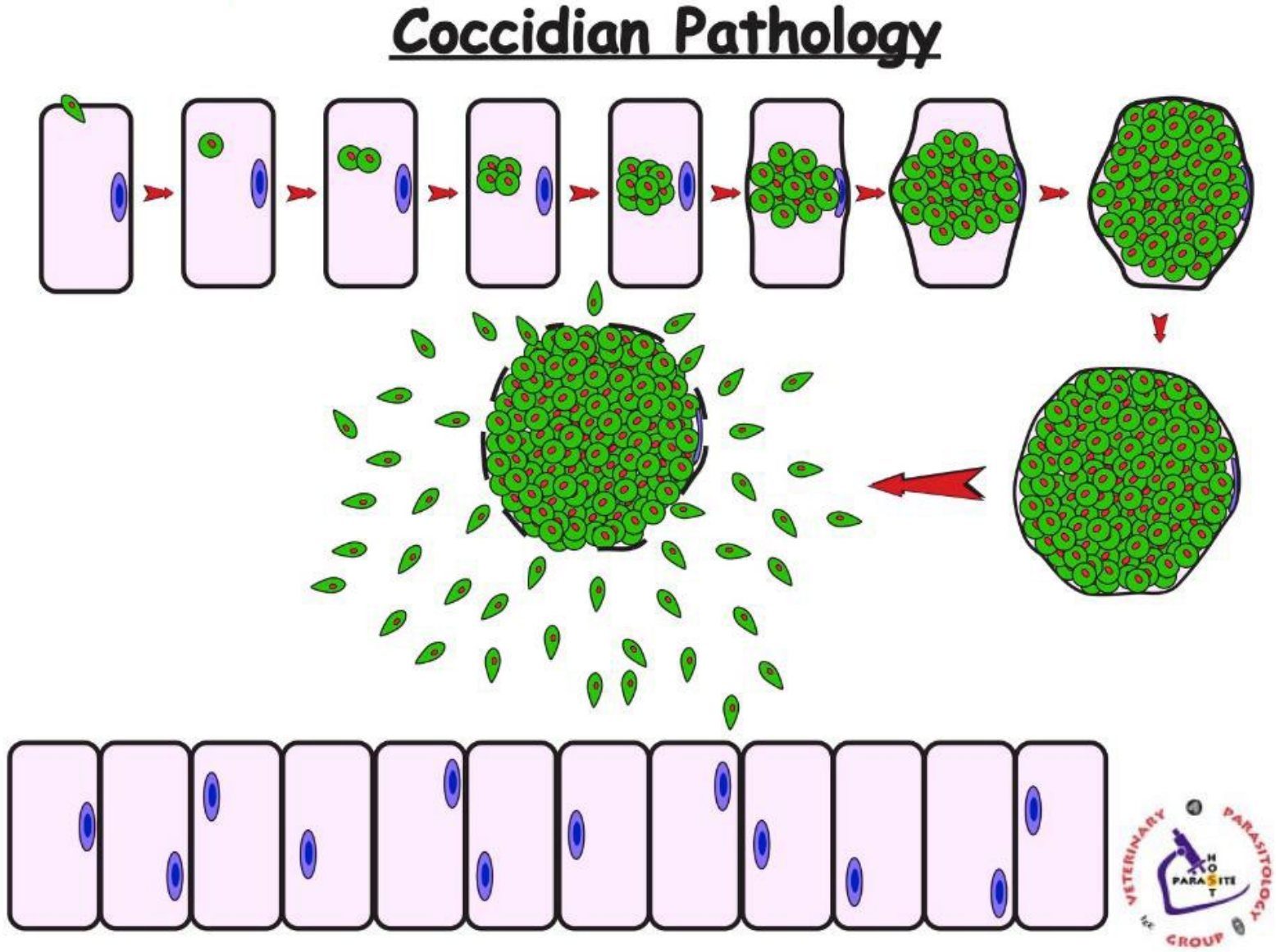
https://www.cdc.gov/dpdx/trypanosomiasisamerican/index.html

Organ and tissue damage will depend on the cells that are destroyed

Direct Destruction

Asexual reproduction inside host cells
→ cellular trauma
→ organ dysfunction

e.g. coccidia destroying enterocytes can cause diarrhea

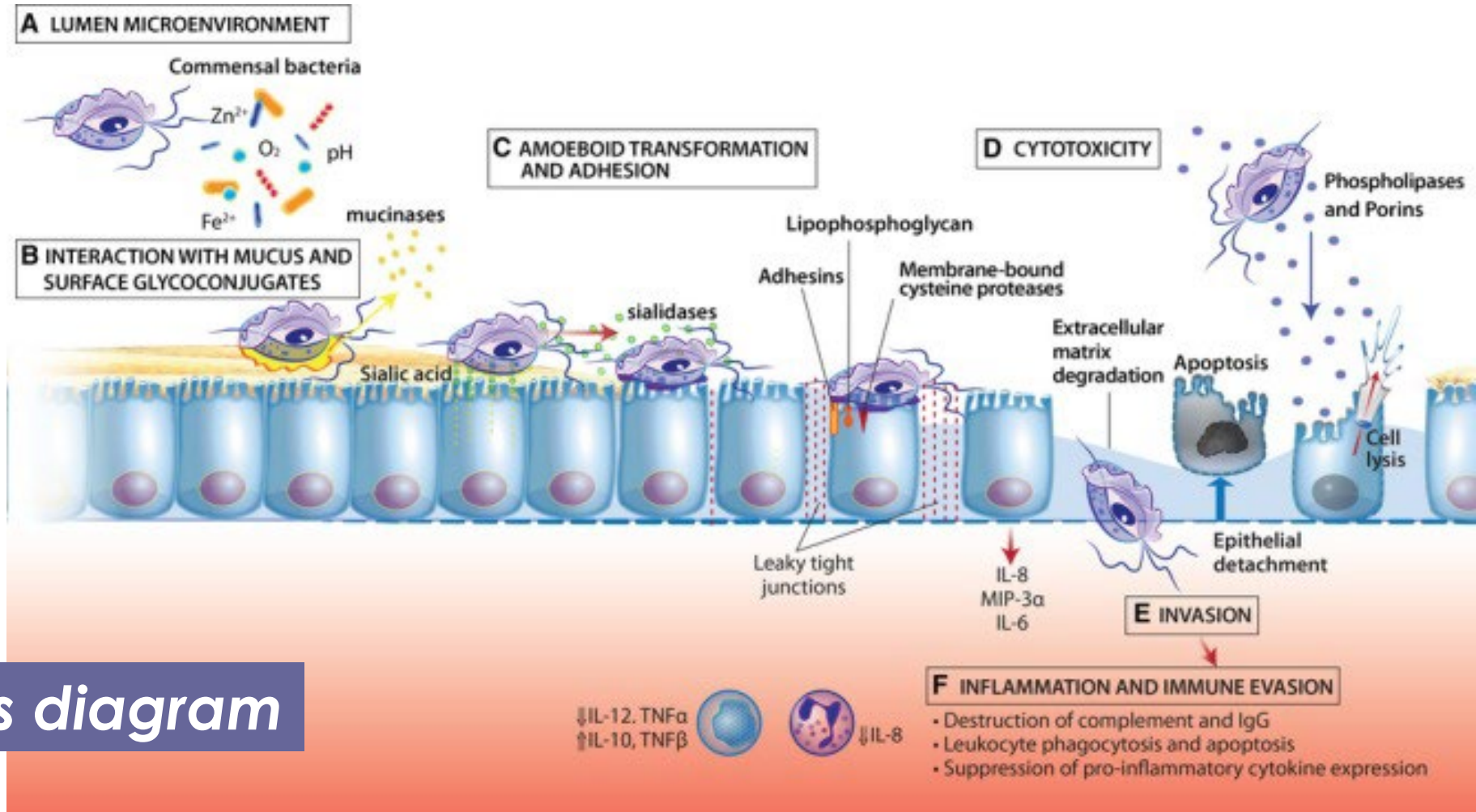


Indirect Destruction

e.g. Tritrichomonas causing damage to the surface of enterocytes causing them to undergo apoptosis

Proliferates on the surface of the host cells.

Causes impairment, damage or apoptosis of the host cells



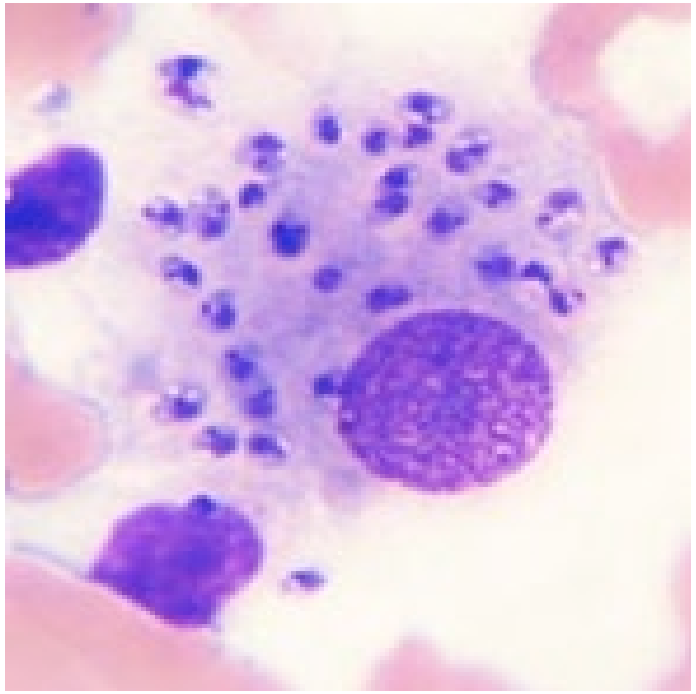
FYI this diagram

Immunomodulation

Autoimmune Reactions

e.g. Babesia can cause the host to generate autoantibodies against red blood cells
(e.g. hemolytic anemia)

Macroagglutination
(anti-RBC antibodies)



Immune suppression

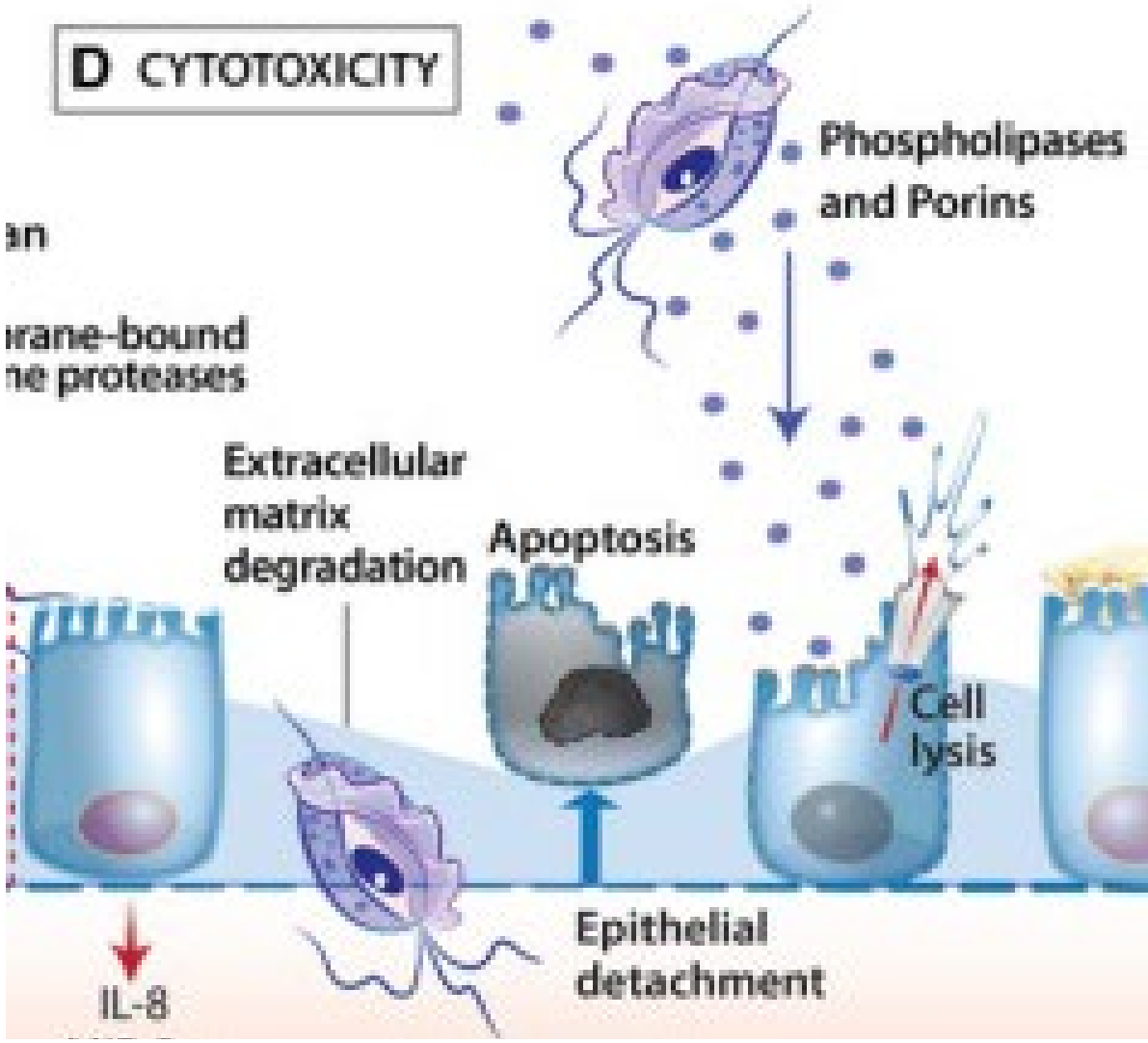
e.g. *Leishmania* alters macrophages to promote its survival (↓antigen presentation, ↓ROS, ↑immune suppressing cytokines

ROS = reactive oxygen species

Excretion of toxins

Most parasitic protozoa secrete toxic substances (low level compared to bacterial endotoxins) *–no specific examples*

Cause inflammation, host cell apoptosis



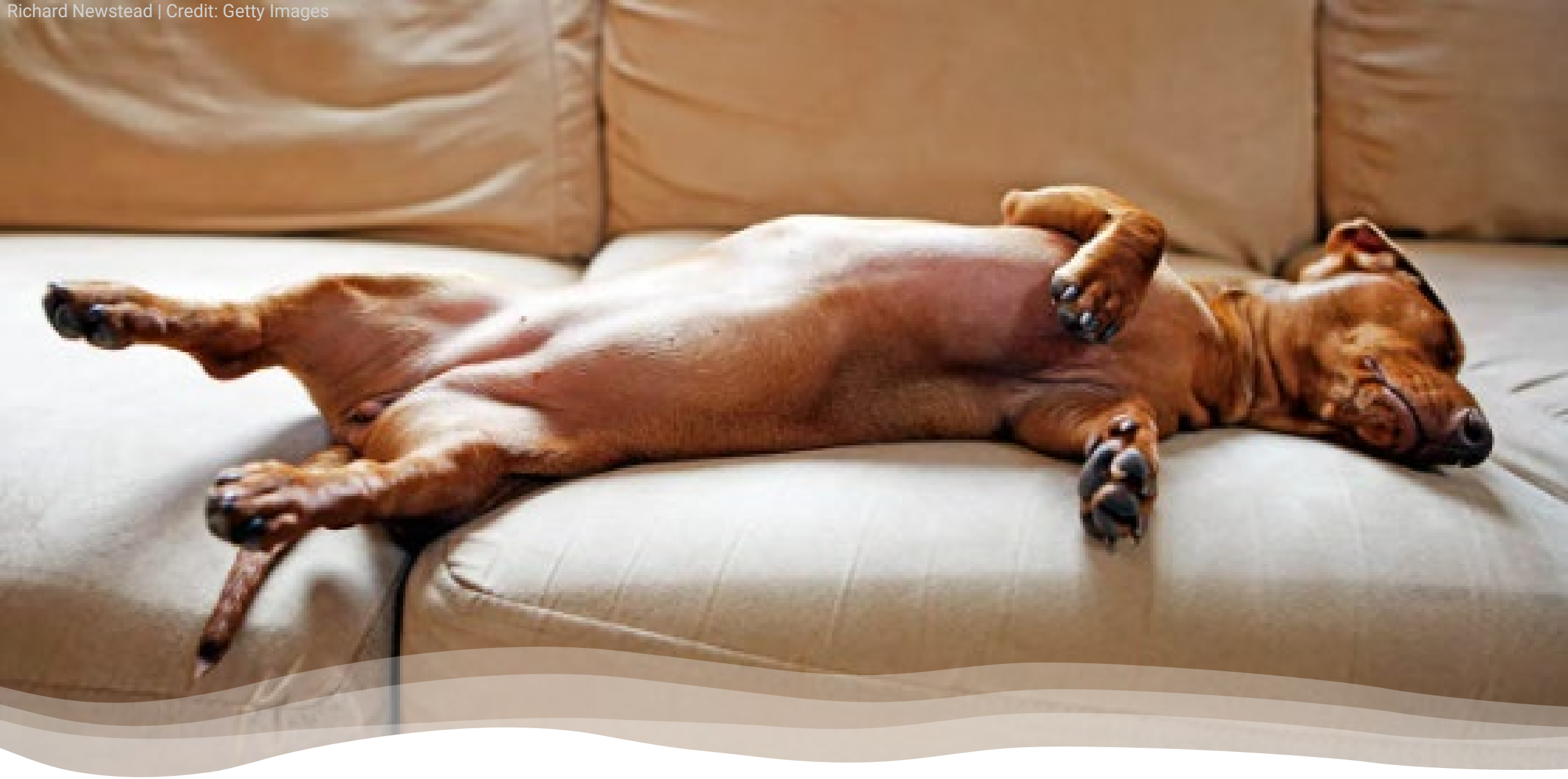
What is the best way to describe an indirect life-cycle?

A. When a parasite's life cycle includes facultative intermediate host species

B. When a parasite's life cycle only includes a single host species

C. When a parasite's life cycle must include an intermediate host species

Name the 4 types of protozoal pathogenesis we JUST discussed?


Richard Newstead | Credit: Getty Images

…there will be no test questions from the following slides

Parasitic Protozoa we cover

Grouped by Infection Site and Motility

Apicomplexa (sg =Alveolates)	Flagellates (sg = Excavates)

Blood

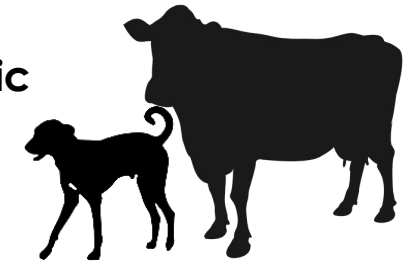
Blood apicomplexa (piroplasms)

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

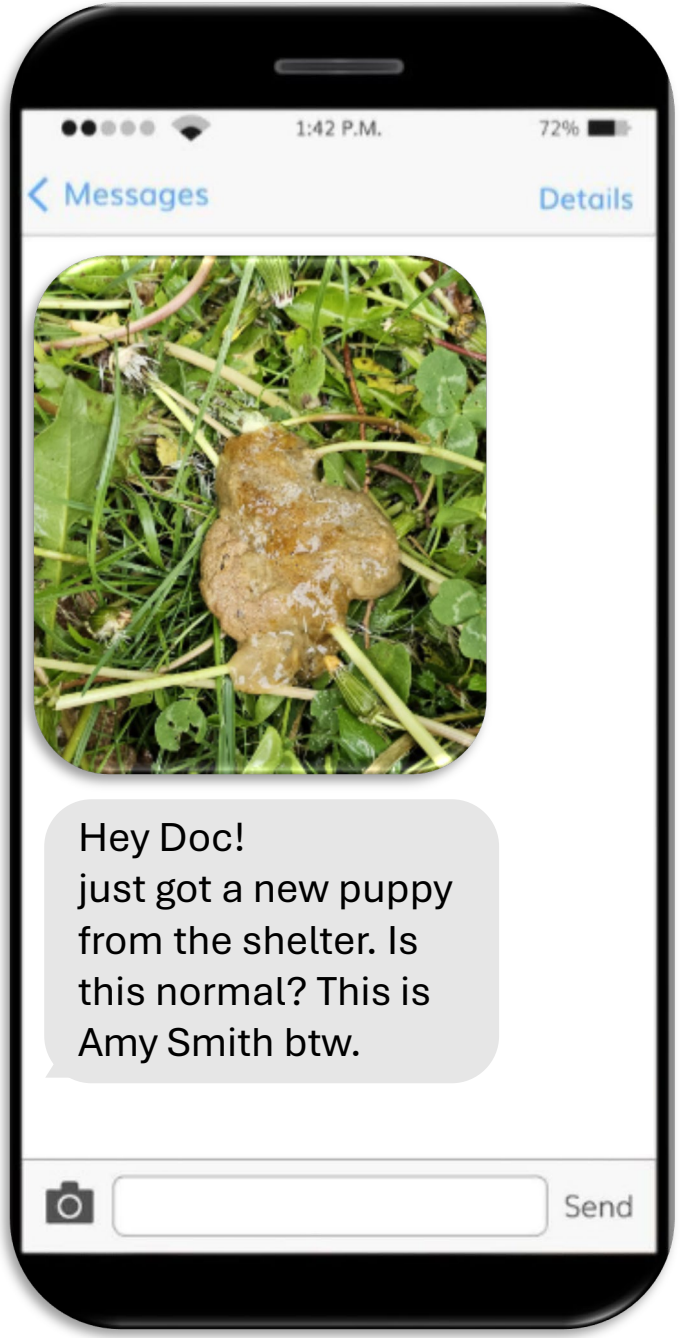
Tritrichomonas foetus
Tritrichomonas blagburni
Giardia spp.

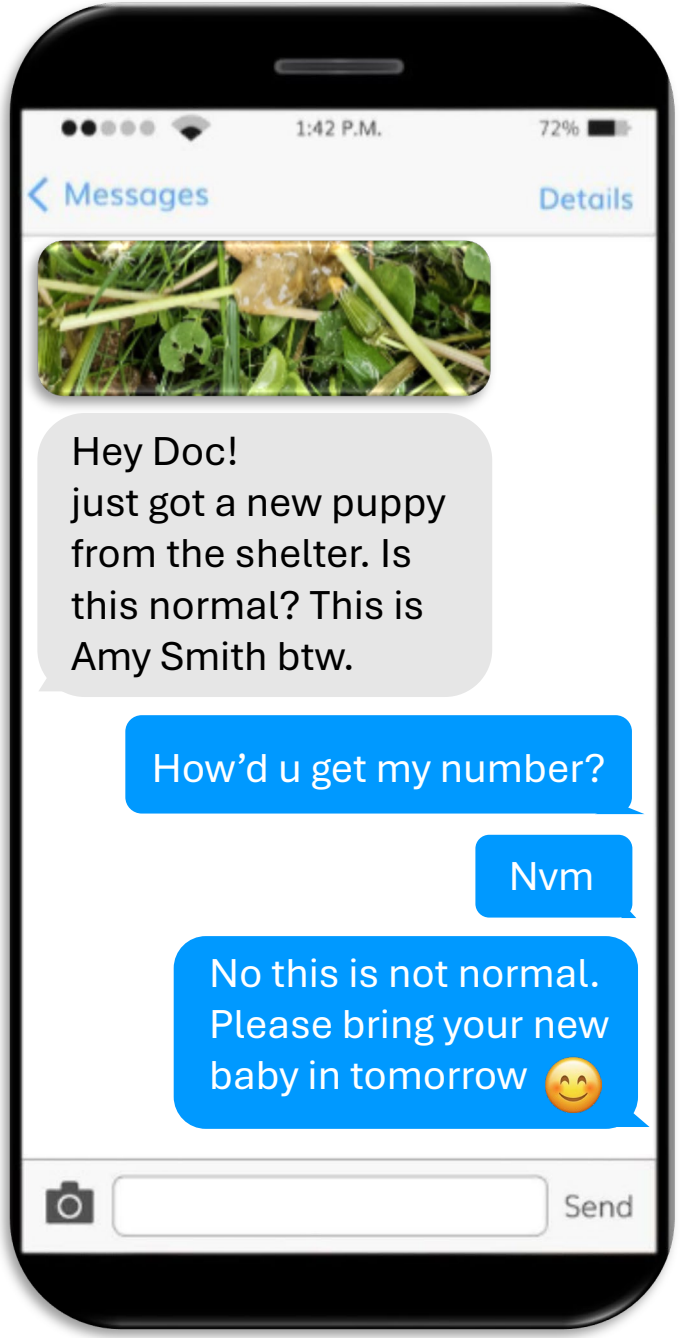
Topics we will cover for each protozoa

1. Life cycle strategies
2. Pathology
3. Host (signs of infection)
4. Diagnosis
5. Treatment / Prevention
6. Epidemiology
7. Zoonosis

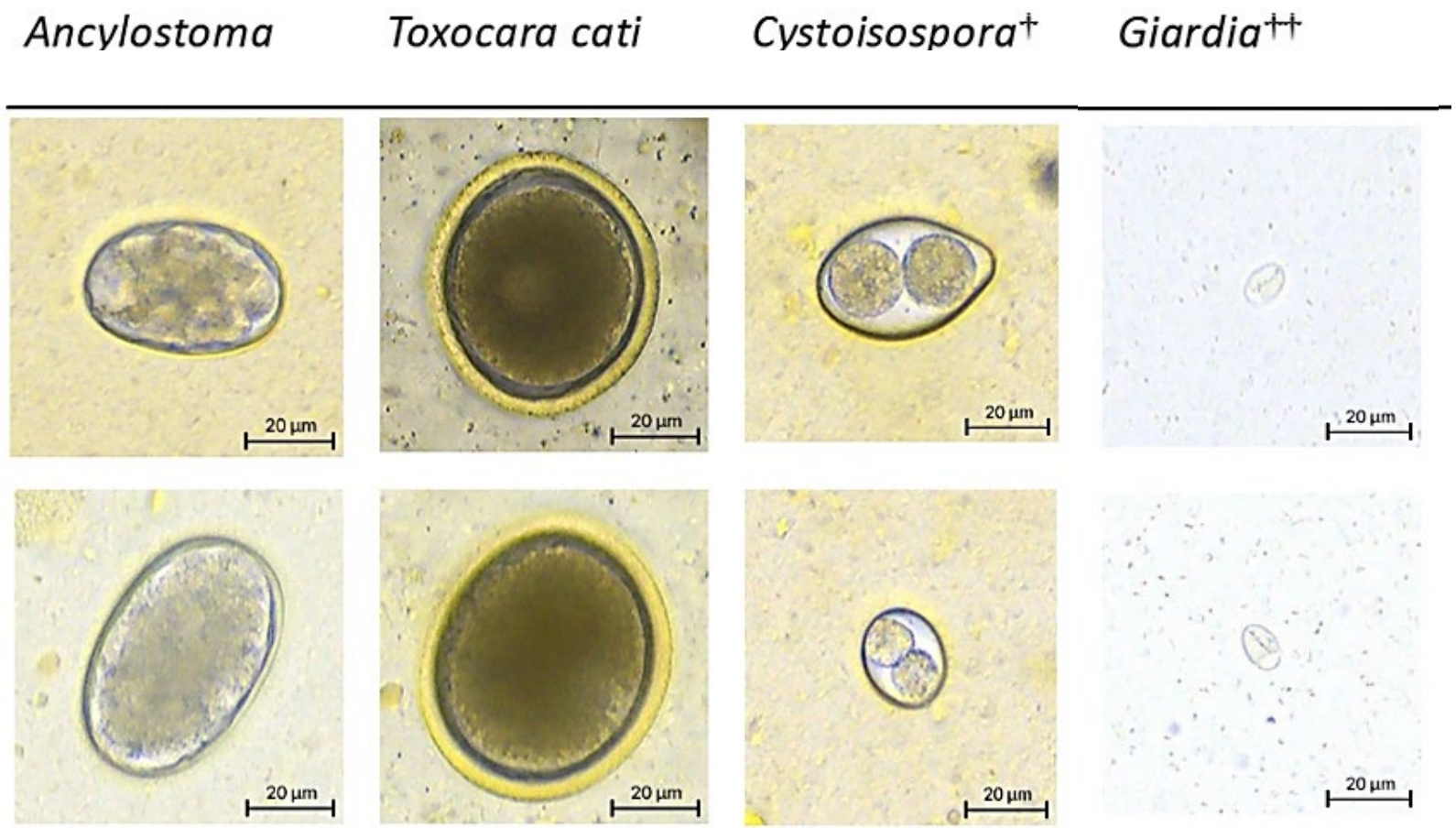
Gather History
Physical Exam
Diagnose
Treat
Prevent
Educate

From this text, what do you know already?





Parasites that can cause diarrhea in dogs



† *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

Signs of Disease in the Host

(Clincopathological = symptoms, PE, laboratory results)

Giardia

History

- +/- Lethargy
- Diarrhea (no blood, chronic)
- Reported weight loss
- Exposure to other dogs/cats or shared spaces
- Recent stress or immunosuppression

Physical Exam Abnormalities

- Pale, soft, loose stool
- +/- painful abdomen
- +/- dilated bowel
- +/- weight loss
- +/- dehydration
- Normal?

Protozoa Diagnostics

1. **Antibodies (host response to infection)**
   1. Collection timing
   2. Exposure vs. Disease

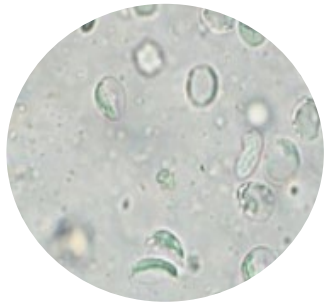
2. **Protozoa (sample where parasite resides)**
   1. Visualize (microscopy)
   2. Detect pathogen protein
   3. Detect pathogen DNA
   4. Culture

GI tract
Urogenital tract
Vasculature
Systemic

Fecal Float
(eggs or cysts)

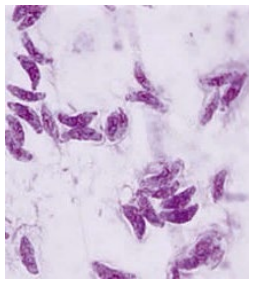
coccidia

Direct Smear
(movement/unstained)



Giardia

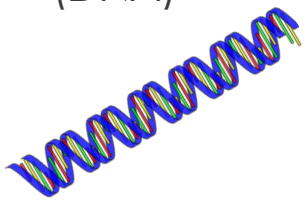
Stain samples



Toxoplasma gondii

Babesia vogeli

PCR
(DNA)



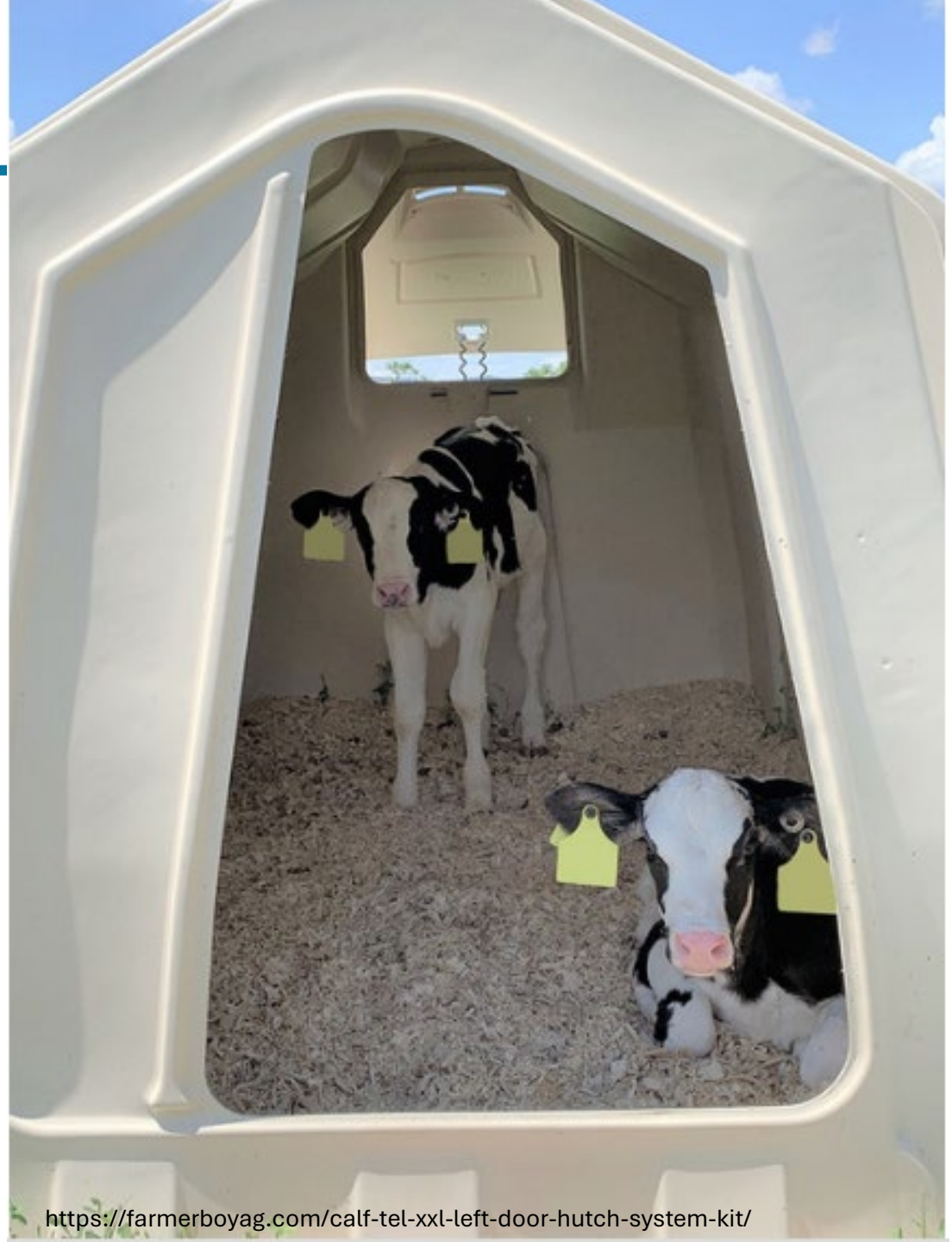
ELISA
(protein)

Treatment

- Recommended meds and supplements
- Clear or prevent infections
- Precautions
- Resistance
- Post-treatment follow-up

Control / Prevention

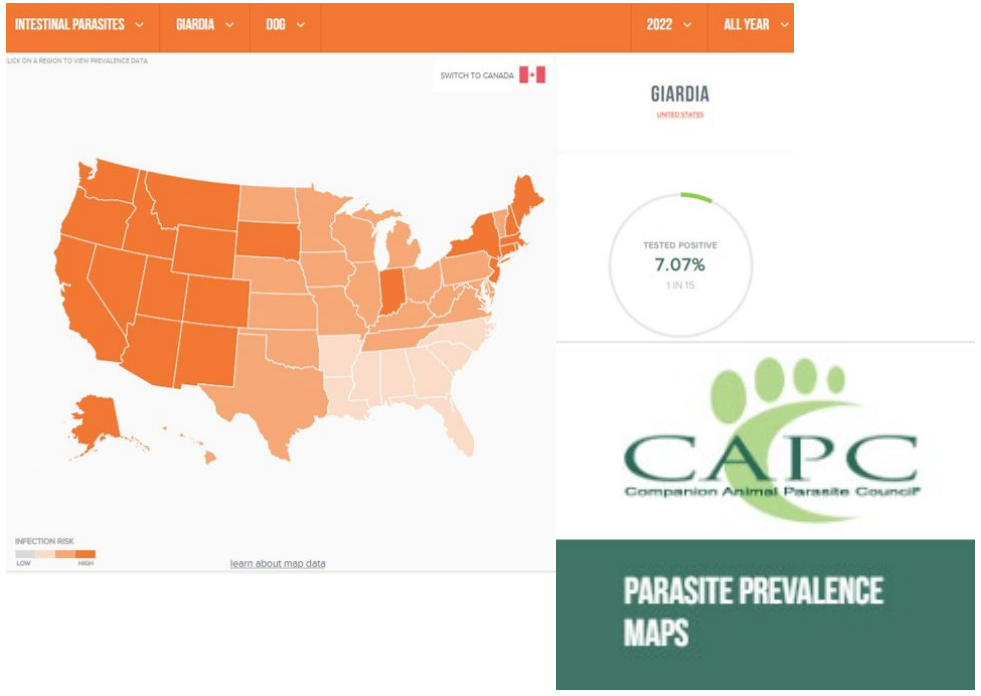
- Prophylactic use of drugs
- Disinfection methods
- Animal husbandry
- Vector control
- Access to other host animals



https://farmerboyag.com/calf-tel-xxl-left-door-hutch-system-kit/

Epidemiology

- Risk factors for infection
- Risk factors for developing disease
- Risk factors for refractory cases
- Prevalence
- Geography



Zoonosis

Giardia grouped by assemblages A-H

Most assemblages are host specific –**zoonosis rare**

- Assemblage C & D (dogs)
- Assemblage F (cats)

Some **concern for immunodeficient people**

baby in tomorrow 😊

Will do, thx! Isn't she so cute!

Zoonosis

Giardia case to be continued…

Diagnosis

- At least 4 different ways you can diagnose Giardia.

Giardia

Treatment

- How would you treat this puppy?
- What do you consider successful treatment?
- What is treatment failure?

Control

- How will you advise the owner to prevent reinfection or infection of their other pets?

Parasitology Pro Tip

	Giardia	Tritrichomonas	Cystoisospora	etc
1. Life cycle strategies				
2. Pathology				
3. Host signs				
4. Diagnosis				
5. Treatment / Prevention				
6. Epidemiology				
7. Zoonosis				

Have Questions?

baquroll@ncsu.edu

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