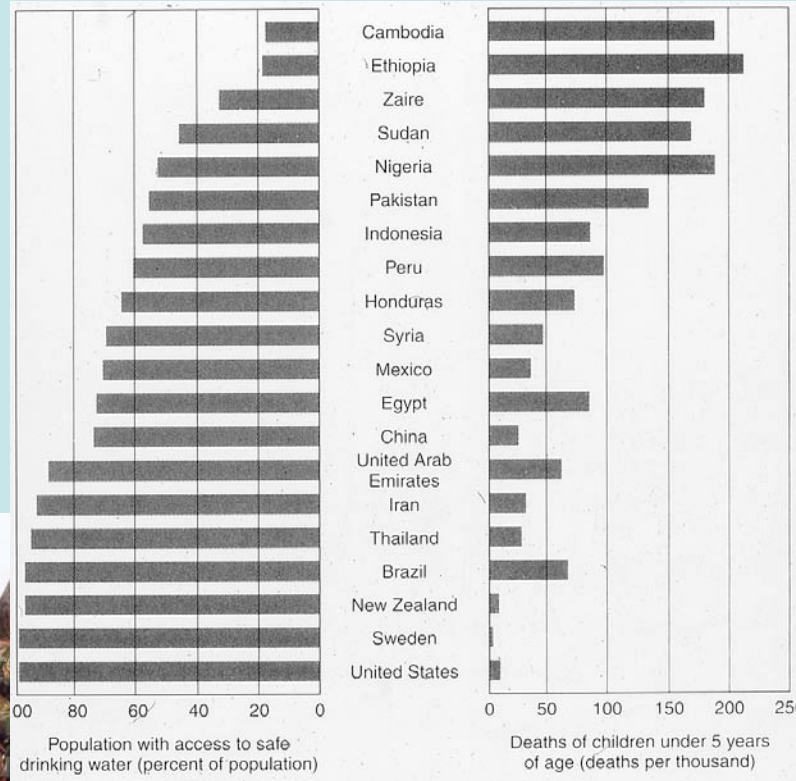
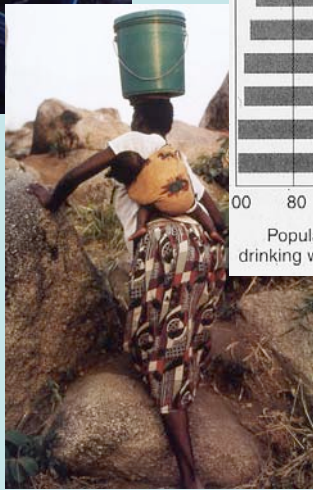


Access to safe drinking water is everyone's right



IMAGINE SURVIVING SEXUAL ASSAULT, GUNFIRE, MORTARS, MACHETES, MALARIA, AND POISON ONLY TO BE KILLED BY A SIP OF WATER.

The Rwandan refugees face new obstacles every hour. Please, give today. With your funds, fresh water, food, medicine and shelter will be supplied to help combat the many enemies in this struggle.

AMERICAN RED CROSS RWANDAN RELIEF, 1-800-842-2200.

Protozoa:

Protozoans that cause diarrheal disease

1. *Giardia lamblia*
2. *Entameba histolytica*
3. *Cryptosporidium parvum*
4. *Cyclospora cayetanensis*

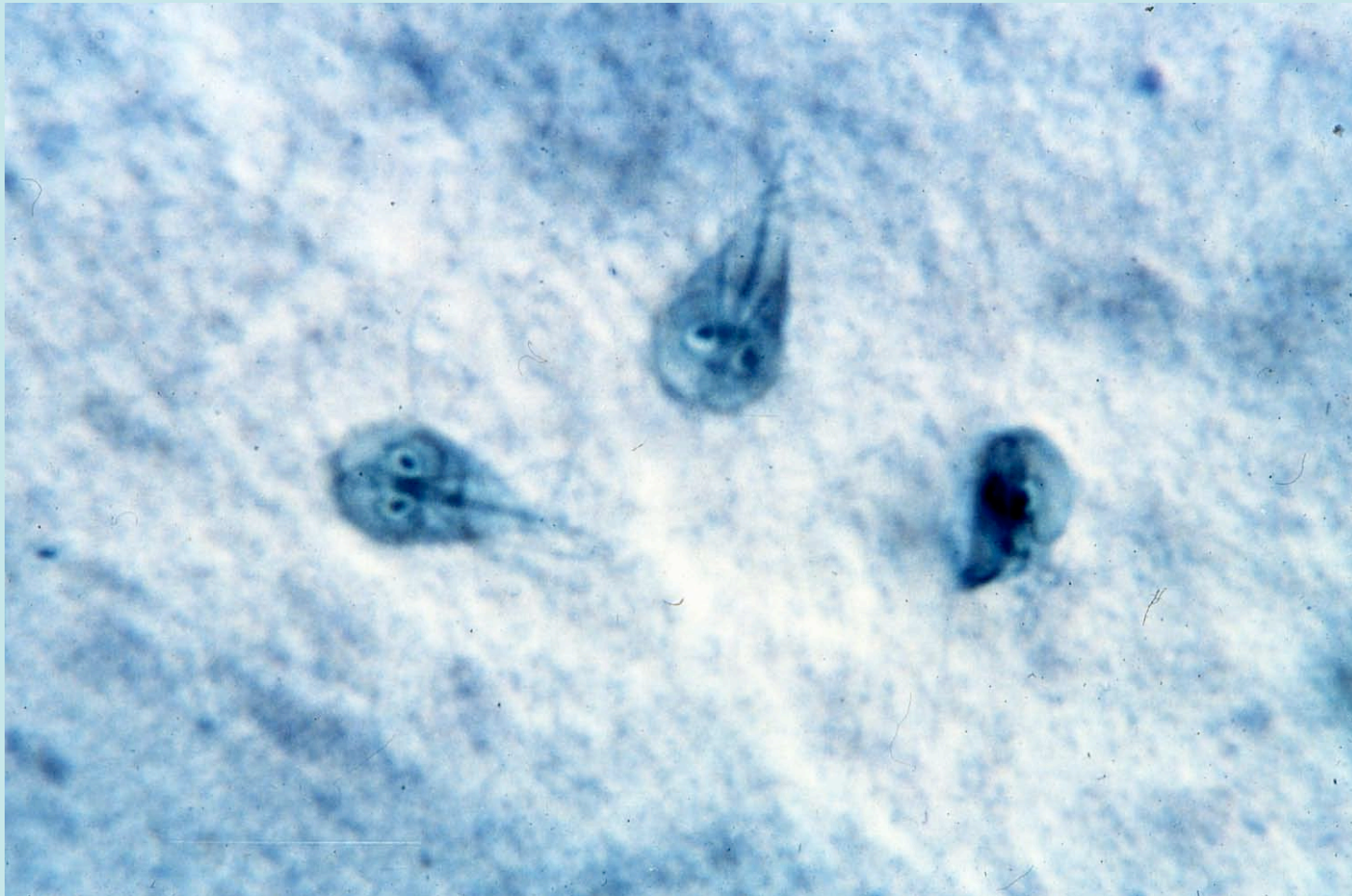


Giardia lamblia

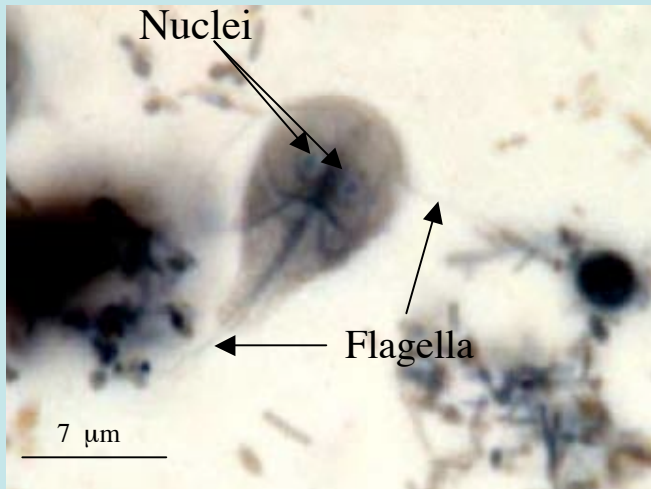
Anton van Leeuwenhoek



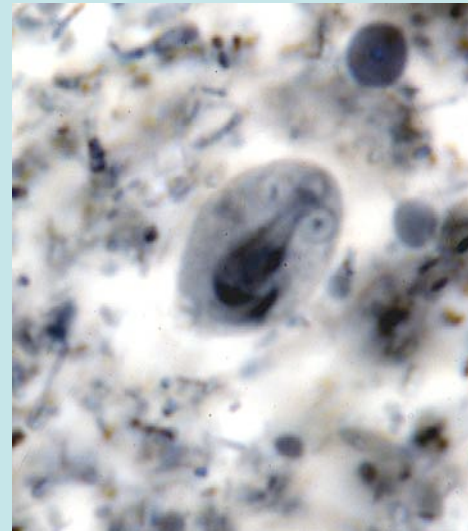
This is what he sees
in his own stool sample



Morphology



Trophozoite



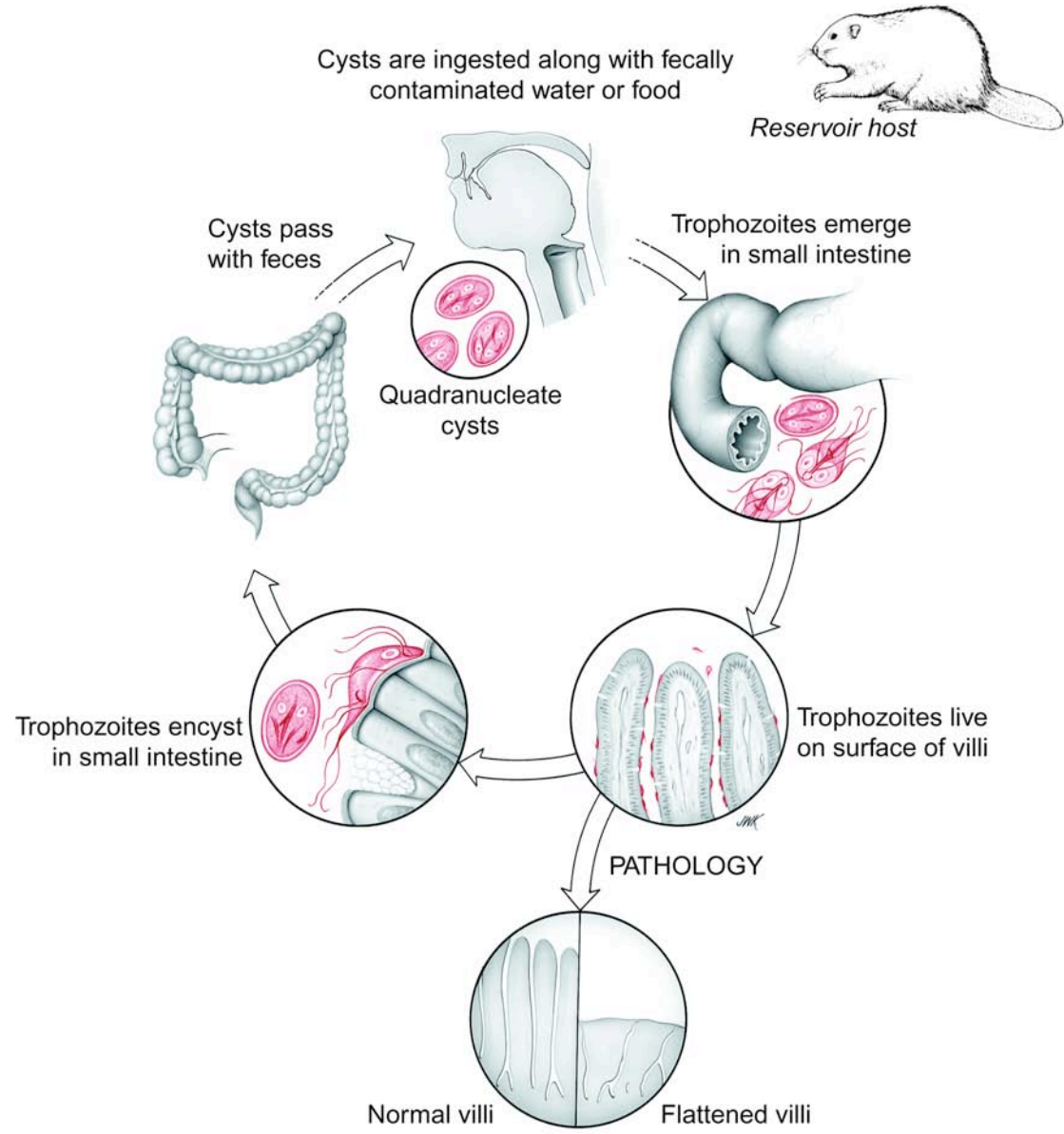
Cyst

Trophozoites of *Giardia lamblia*



Hope you all had
a nice Thanksgiving!

Giardia lamblia



Biopsy of small intestine
positive for *Giardia lamblia*



SEM of *Giardia lamblia* in situ

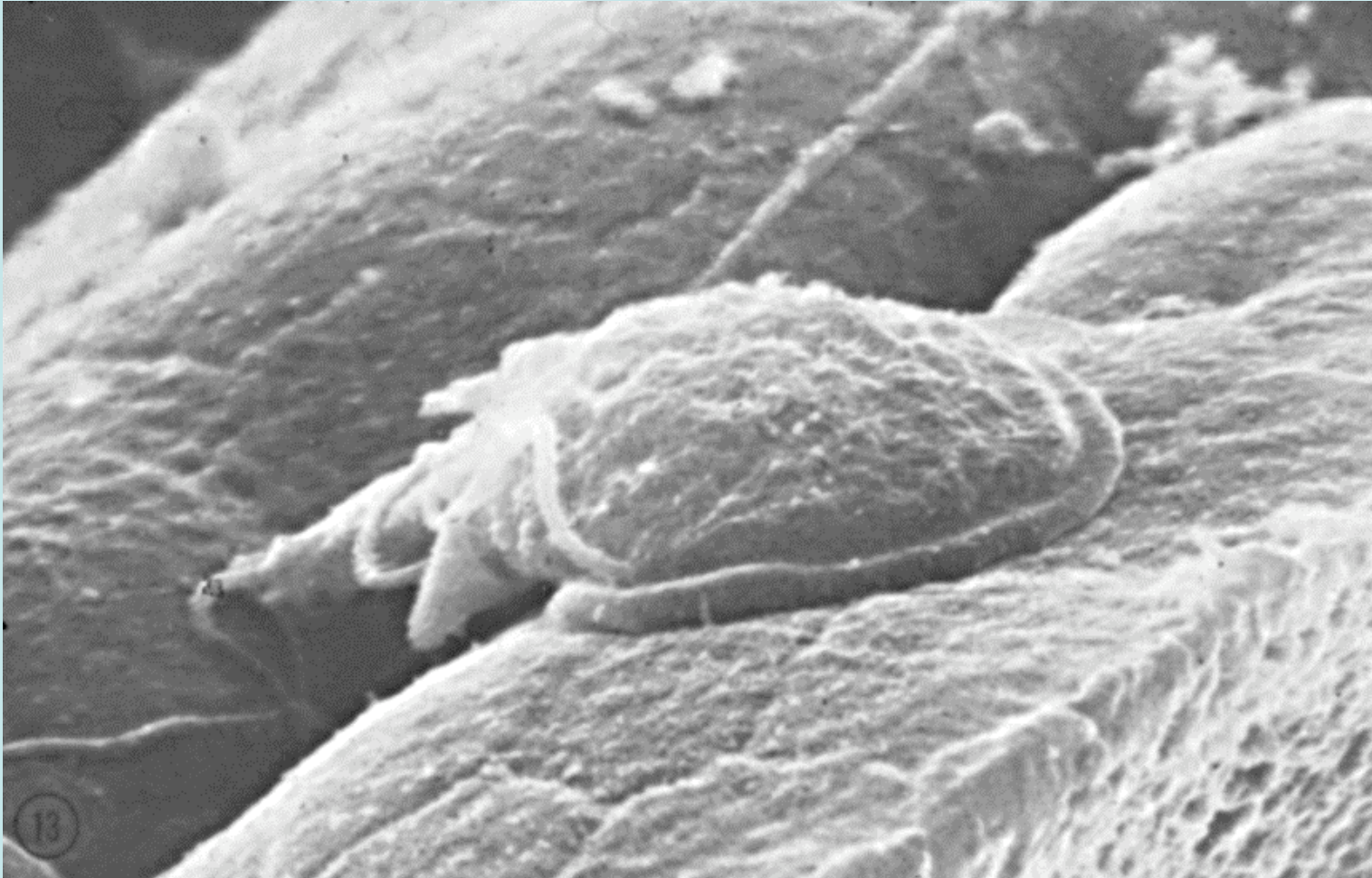
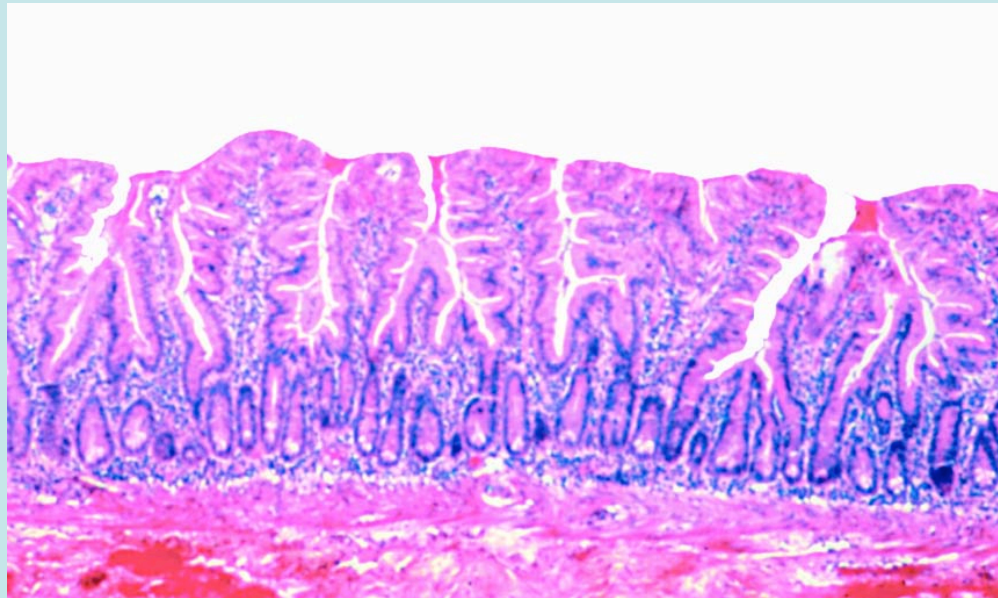


Photo courtesy R. Owen

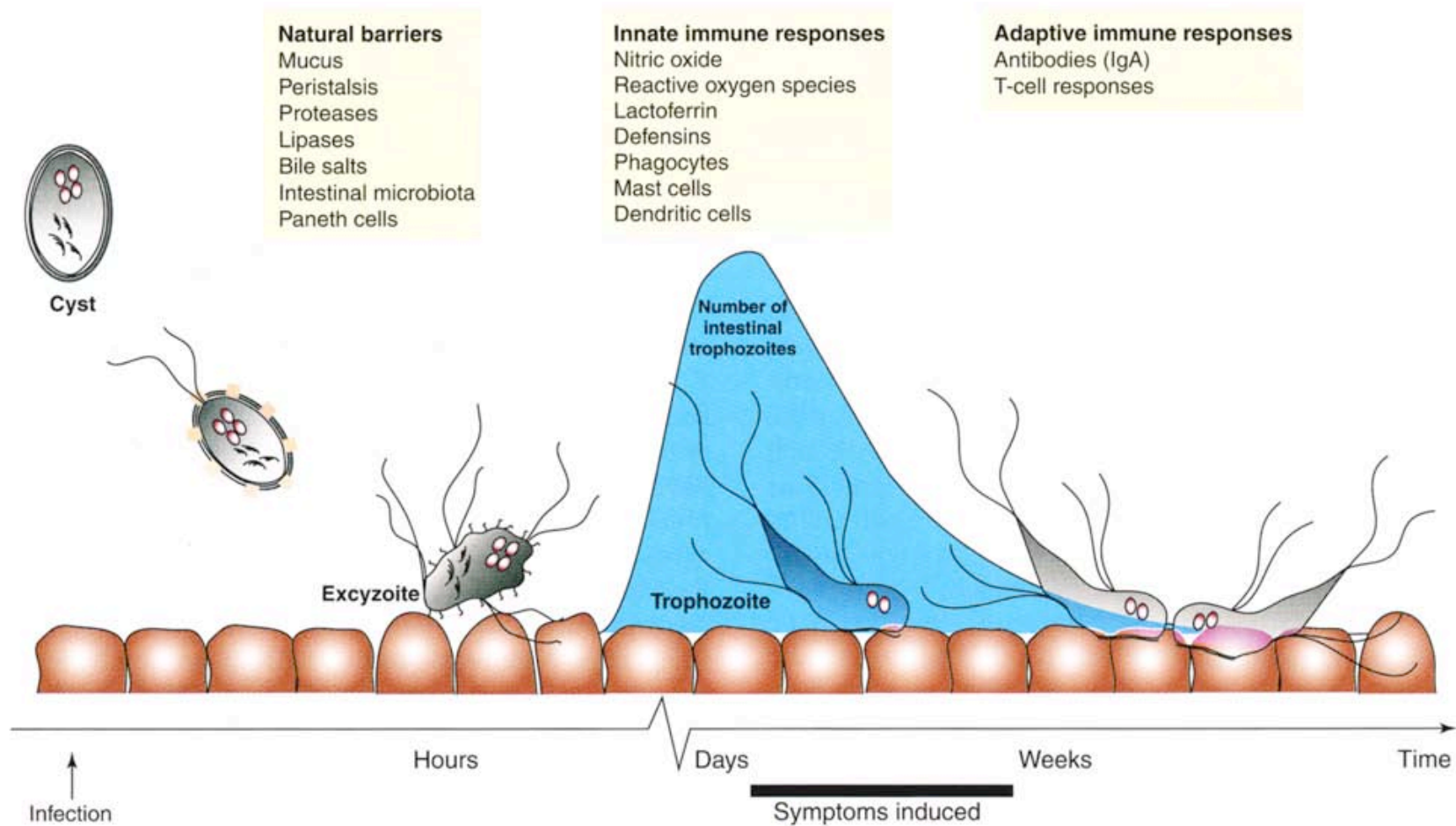
Pathogenesis:

Trophozoite stage induces malabsorption of fats.
Mechanism(s) unknown.



Histopathological correlate: Flattened villi

Giardia and Immune Mechanisms



Clinical Disease:

Diarrhea (steatorrhea)

Weight loss

Constipation

Fatigue

Diagnosis:

1. Identify trophozoites and cysts by microscopic examination of stool



8 μ m

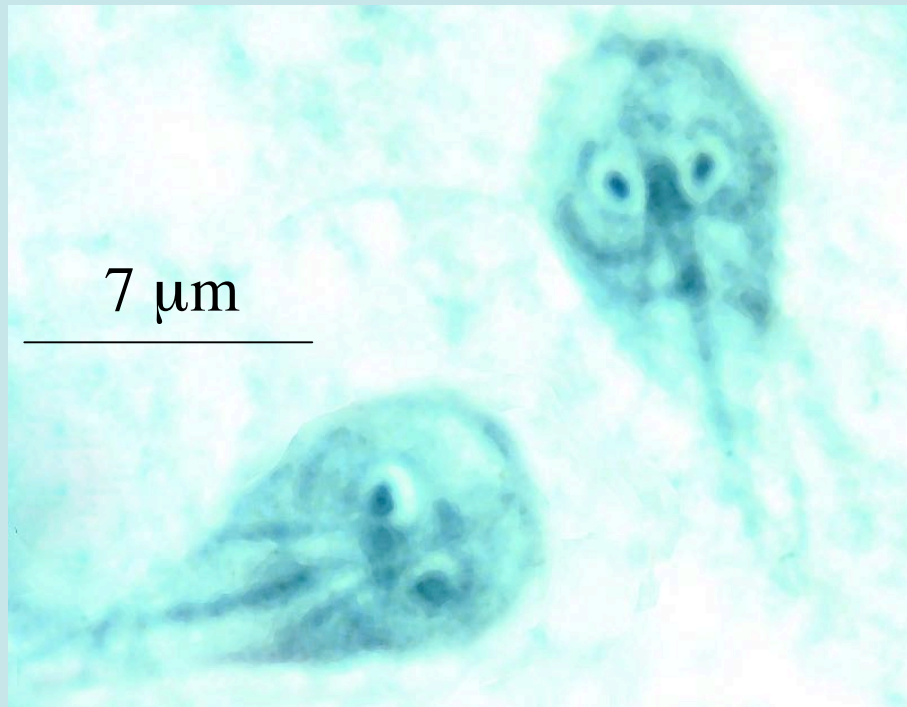
Trophozoite



Cyst

Diagnosis (cont'd):

2. Identify trophozoites on microscopic examination of fluid from string test.

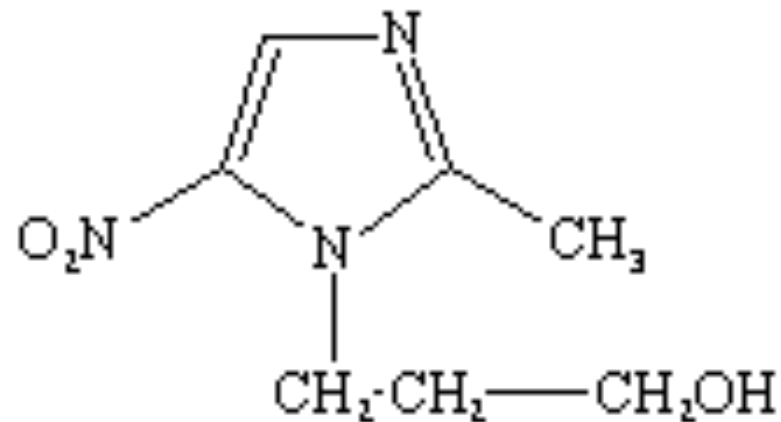


A 96-well ELISA microplate is shown, with a grid of wells. The wells contain liquids of varying colors, including orange, yellow, and clear, representing different test results. The text is overlaid on the top-left portion of the plate.

Diagnosis (cont'd):

3. Antigen Capture-ELISA from stool sample

Drug of choice: Metronidazole



Mode of Action:

Inhibits anaerobic metabolism by interfering with oxidoreductase, a protozoan-specific enzyme.

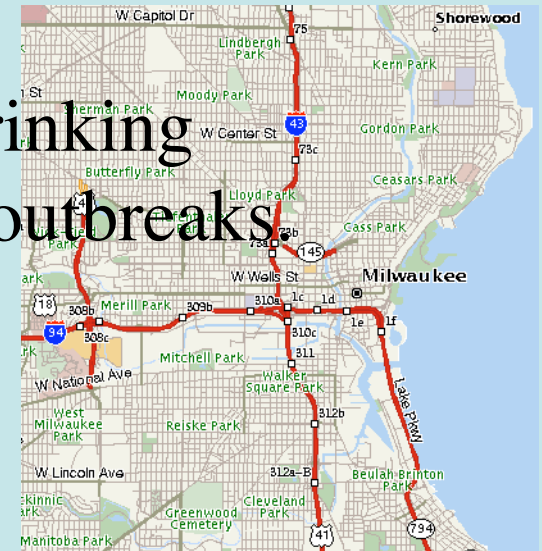
Medical Ecology:



1. Reservoir hosts - beaver, dog

2. Day-care centers are common point sources for outbreaks.

3. Break-downs at filtration plants for drinking water supplies have led to major outbreaks



Prevention and Control:

1. Sanitary disposal of feces



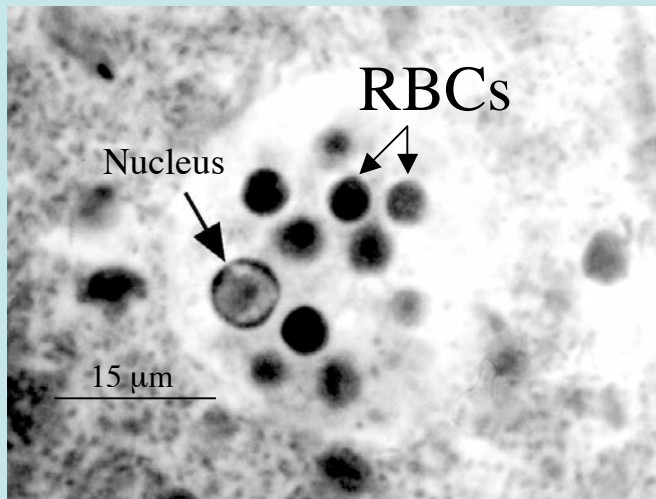
Prevention and Control (cont'd):

2. Safe drinking water supply -maintain watersheds or filter water.
3. Maintain good sanitary practices at day-care facilities - difficult to enforce among small children due to PICA
4. Don't drink unfiltered water from "pristine" rivers and streams while enjoying the great outdoors.

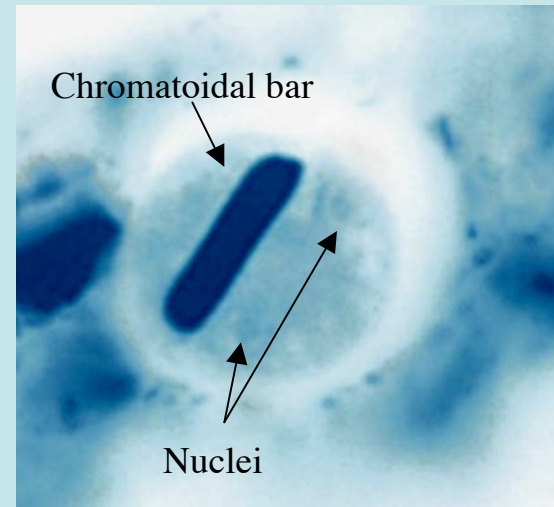
A light micrograph showing several trophozoites of Entamoeba histolytica. The organisms are roughly spherical and have a distinct outer membrane. Each trophozoite contains a large, dark, centrally located nucleus with a prominent, dark nucleolus. The background is a light, granular material, likely host tissue or culture medium. The text "Entamoeba histolytica" is overlaid in the center of the image in a black, italicized serif font.

Entamoeba histolytica

Morphology

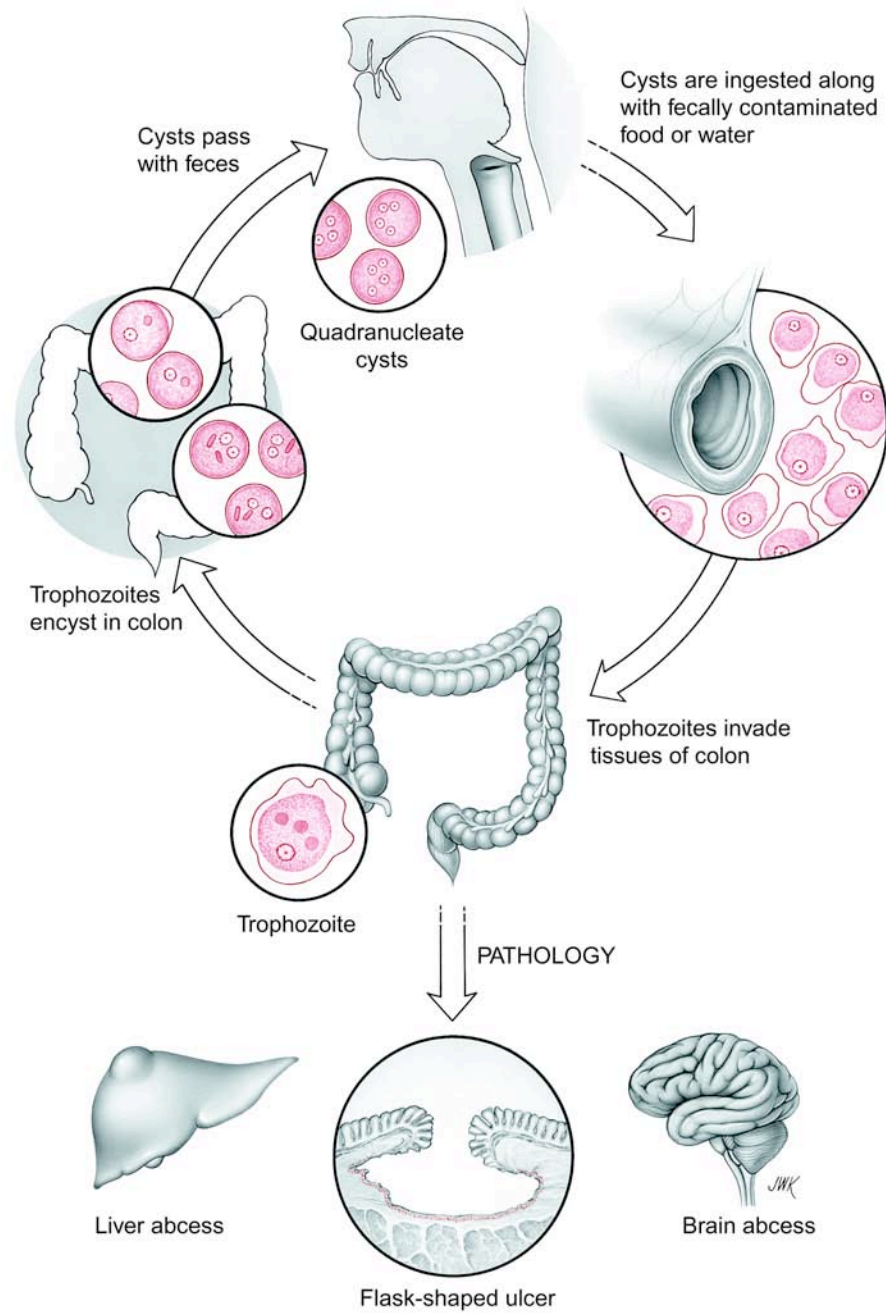


Trophozoite

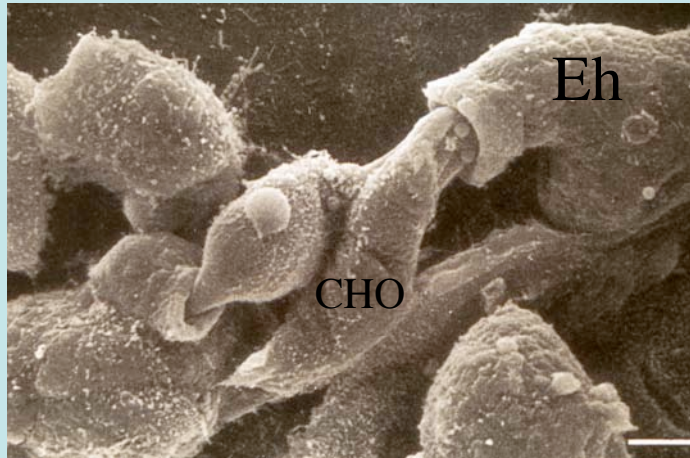


Cyst

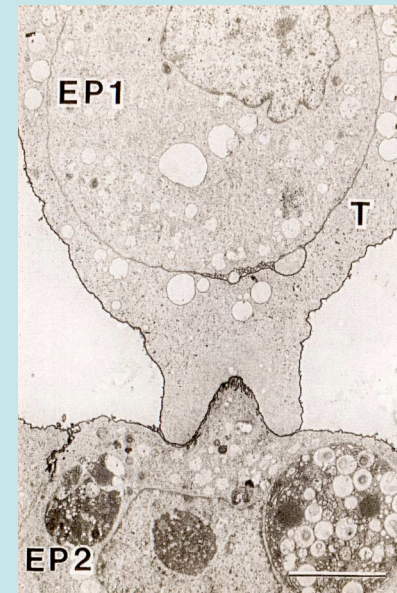
Entamoeba histolytica



Entameba histolytica in culture
with Chinese hamster ovary cells



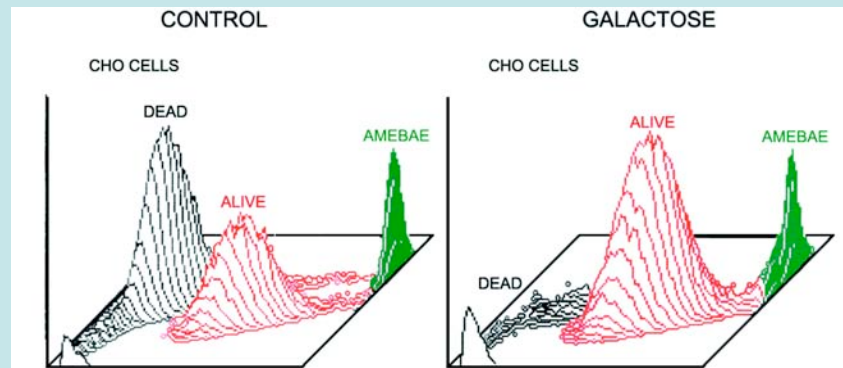
SEM



TEM

Pathogenesis:

1. Attachment of amebae to target cells mediated by galactose, then pore-forming protein disrupts target cell membrane:



From: Ravdin, J.I. (1995) Amebiasis (Review). *Clin. Infect. Dis.* **20**: 1453-1466

2. Cell-cell contact induces synthesis of lysosomal enzymes in amebae at interface with target cells. Cell death ensues.

Clinical Disease:

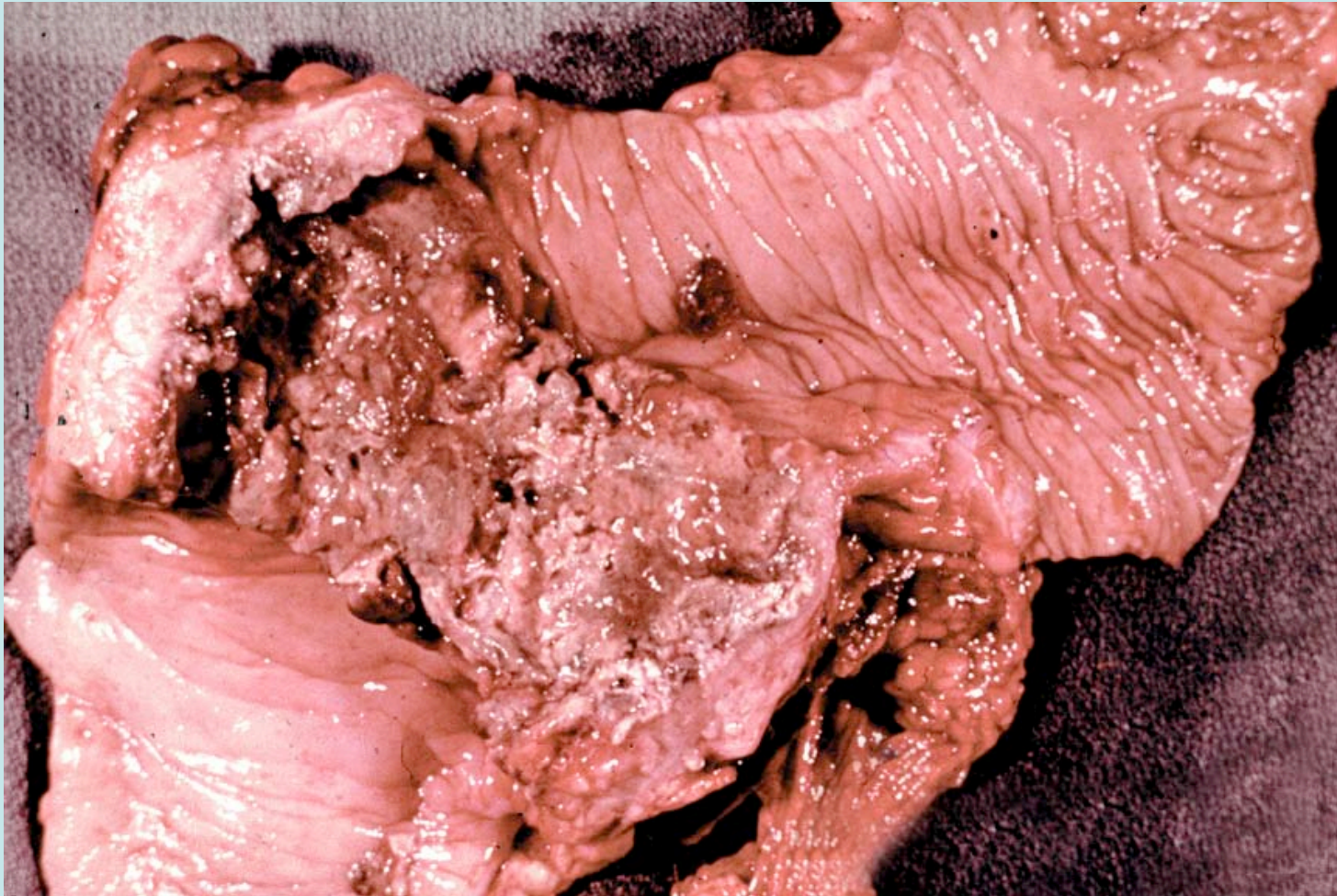
A. Intestinal:

1. Diarrhea
2. Dysentery (bloody diarrhea)

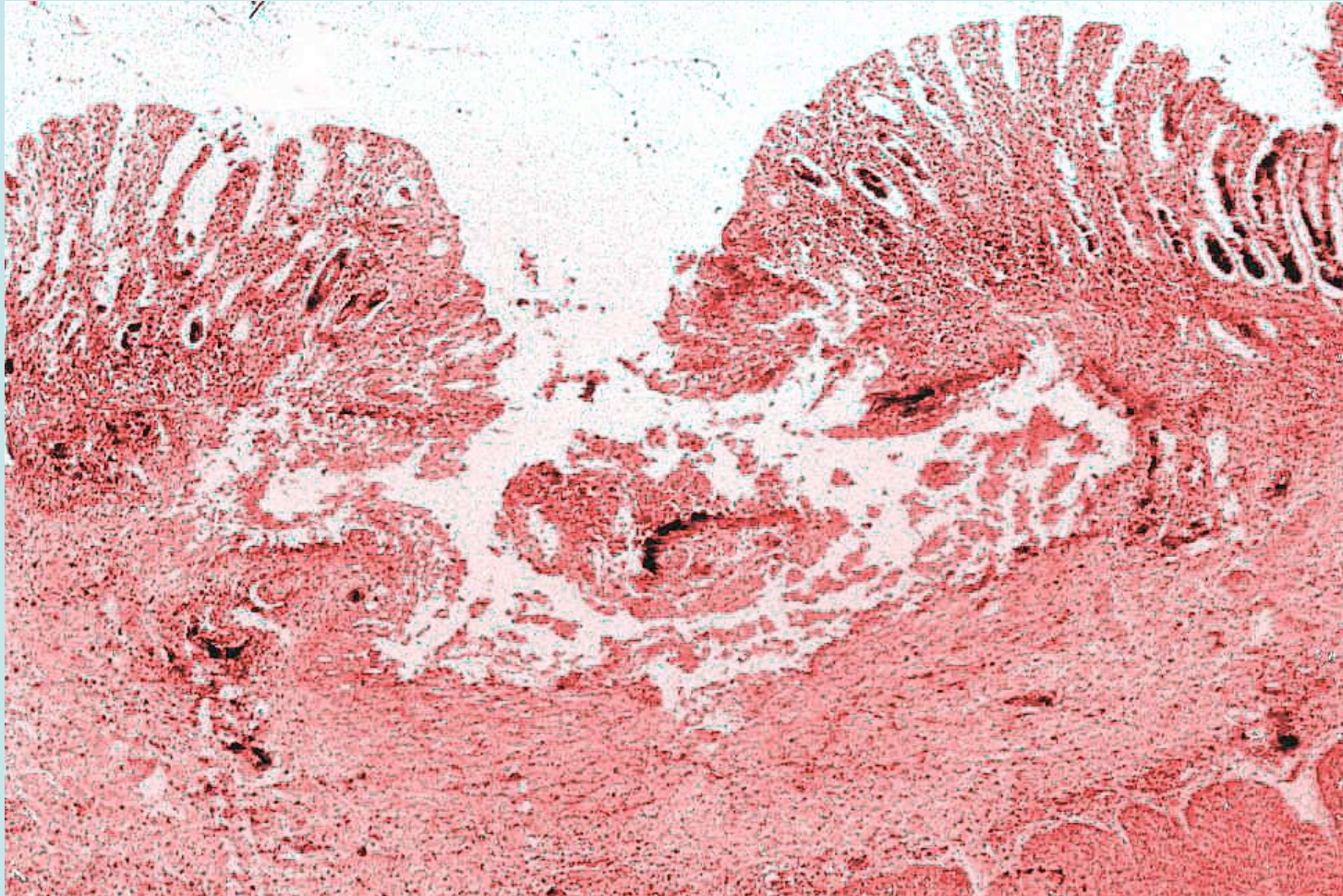
B. Extra-intestinal:

1. Liver abscess (most common site)
2. Lung abscess
3. Brain abscess (usually fatal)

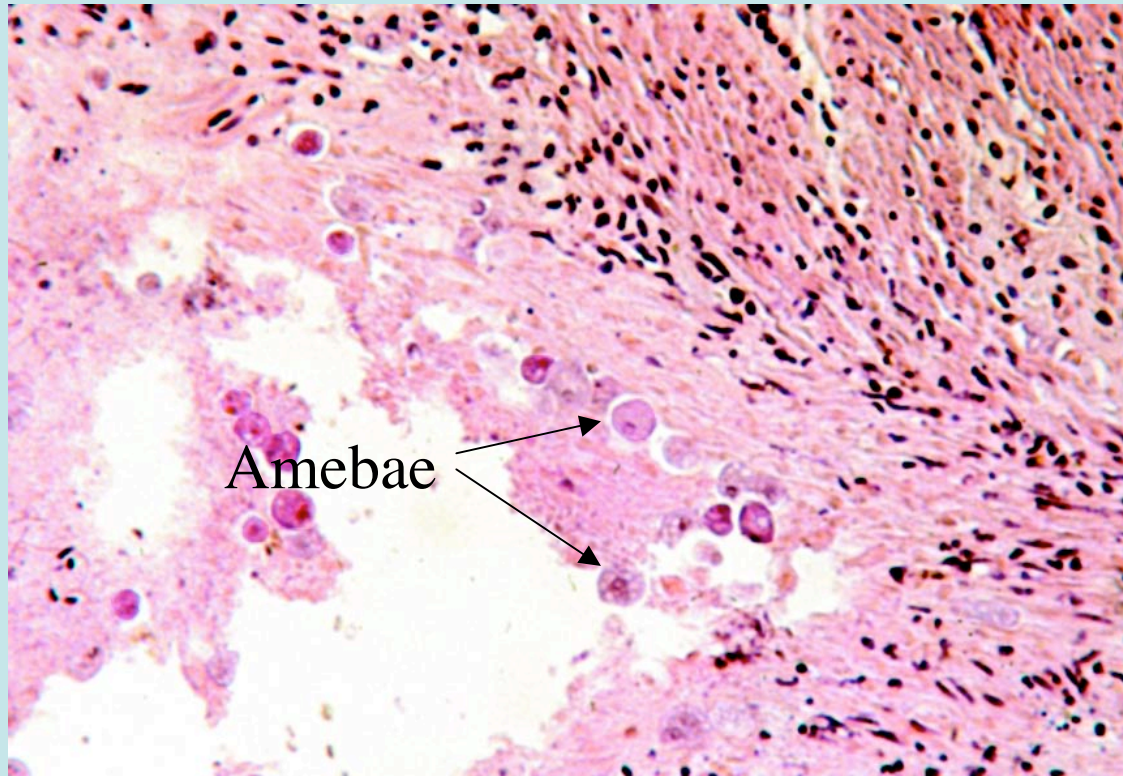
Gross pathology of large intestine due to *Entameba histolytica*



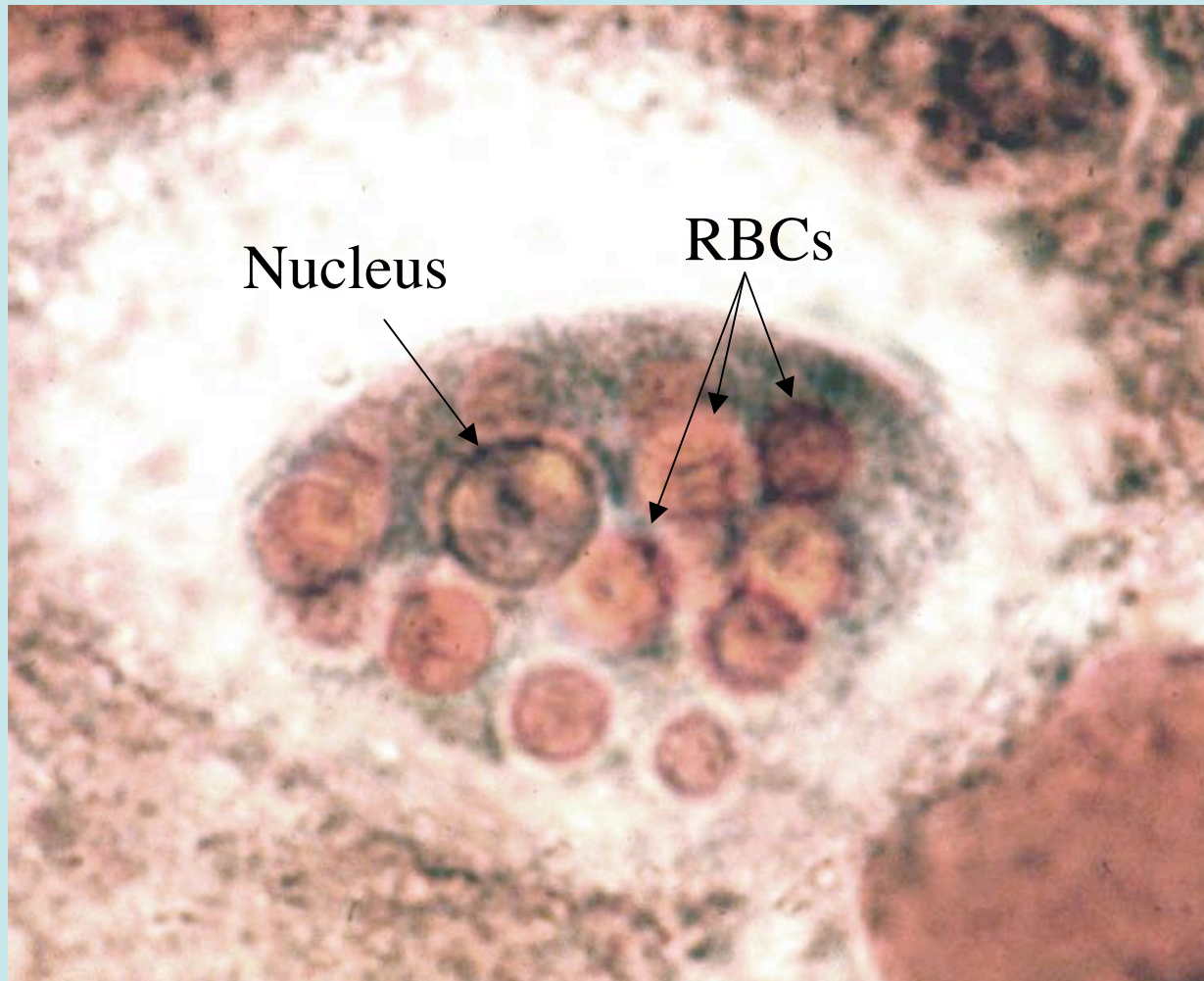
Flask-shaped ulcer due to infection
with *Entameba histolytica*



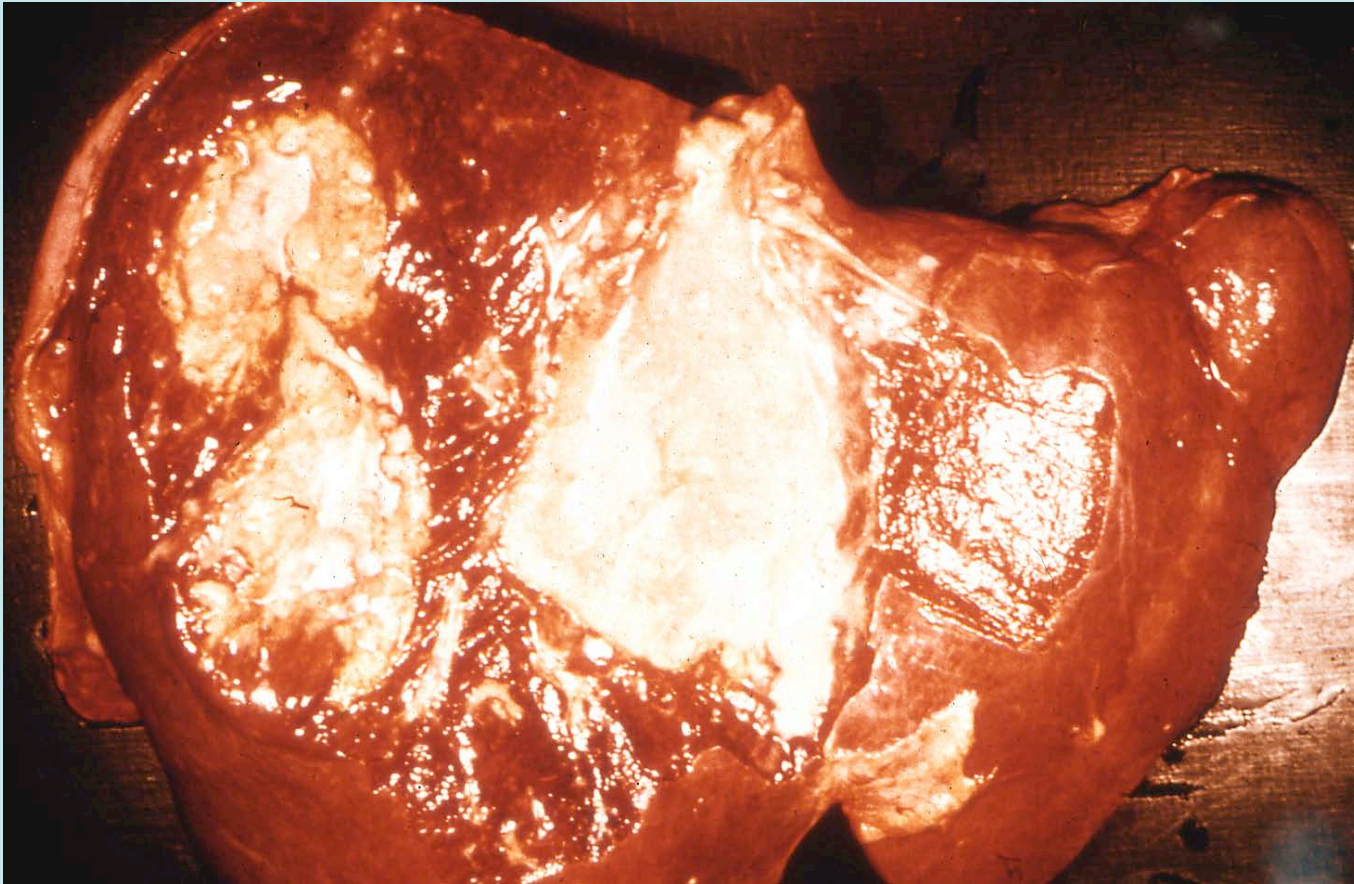
Trophozoites of *Entameba histolytica*
in situ in flask-shaped ulcer



Trophozoite of *Entameba histolytica*
with RBCs in cytoplasm



Multiple abscesses in liver from
a fatal case of *Entameba histolytica*



Courtesy WHO

Diagnosis:

1. Identify trophozoites and/or cysts in feces.

Cannot distinguish *E. histolytica* from *E. dispar* by morphology unless cytoplasm contains RBCs.



Trophozoite



Photo: CDC

Cyst

Diagnosis (cont'd):

2. Antigen Capture ELISA using stool sample

3. PCR

4. IHA serology:

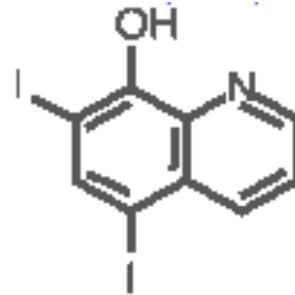
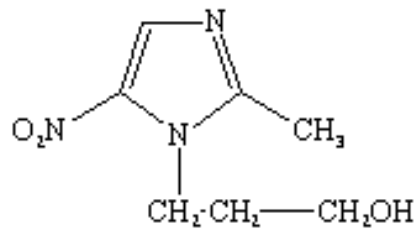
Intestinal - 95% predictive of active infection

Extra-intestinal - 100% predictive of active infection

Drugs of Choice:

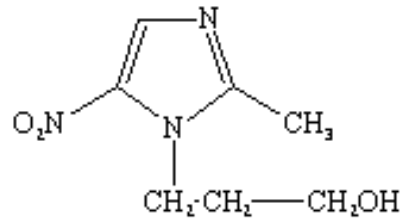
1. Intestinal:

Metronidazole and Iodoquinol



2. Extra-intestinal

High doses of Metronidazole



Prevention and Control:

Sanitary disposal of feces

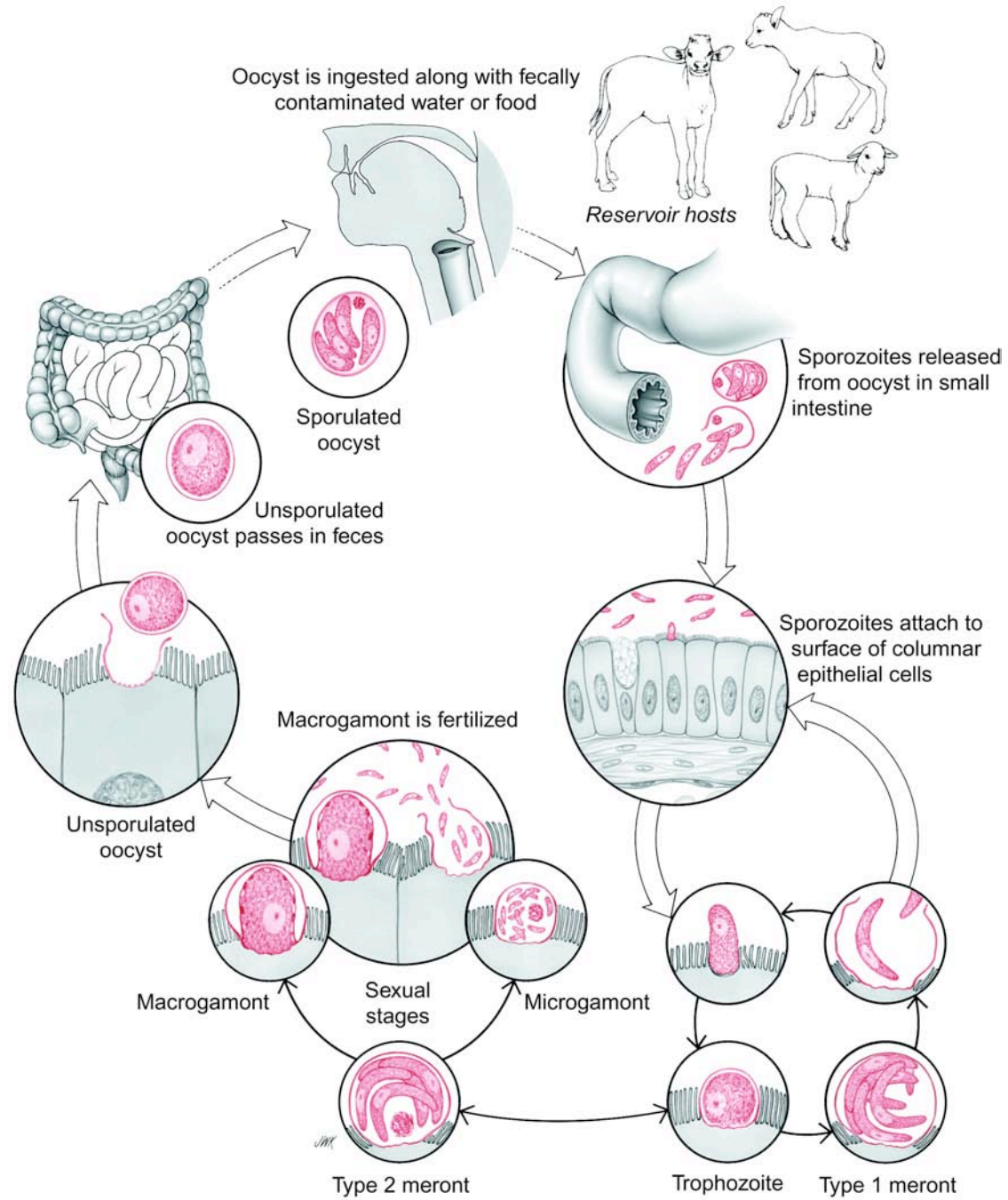




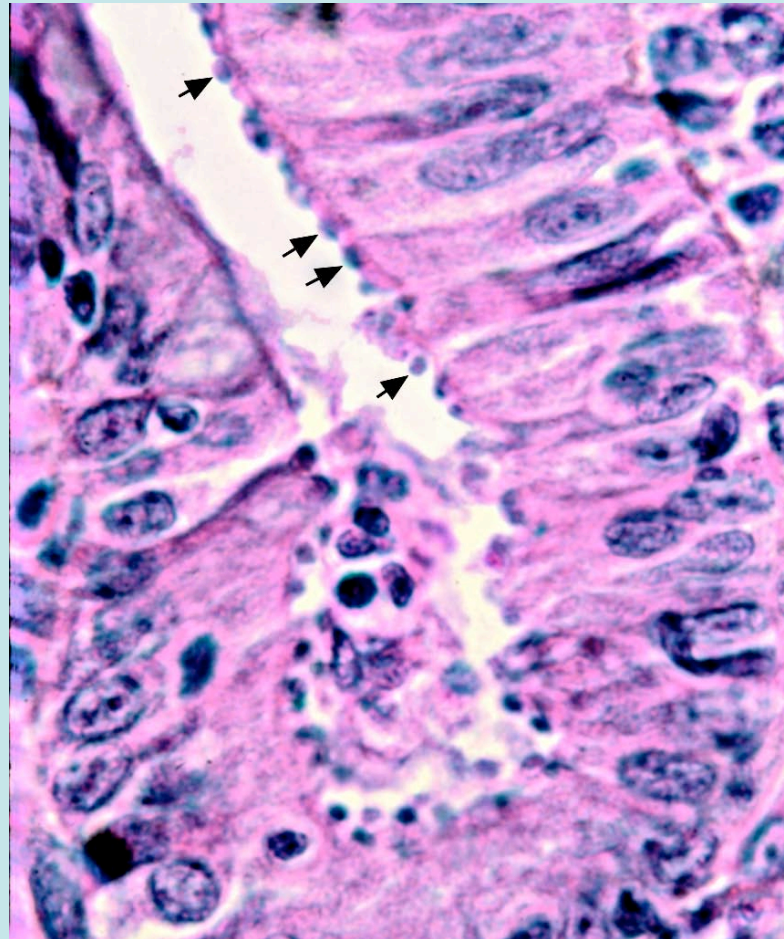
Cryptosporidium parvum



Cryptosporidium parvum



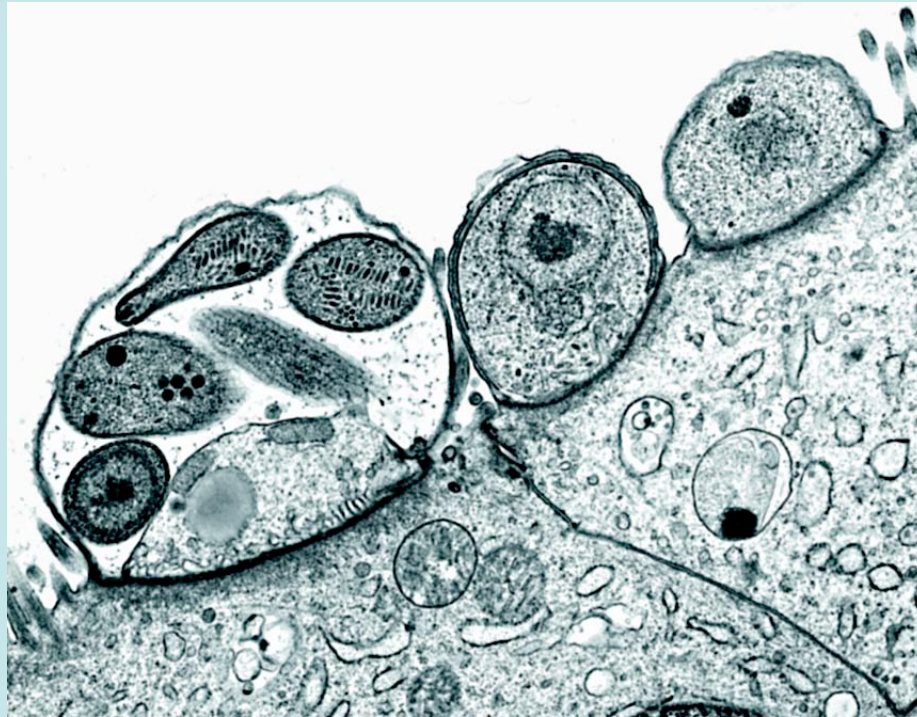
Histologic section of small intestine of patient suffering from HIV/AIDS, infected with *Cryptosporidium parvum*.



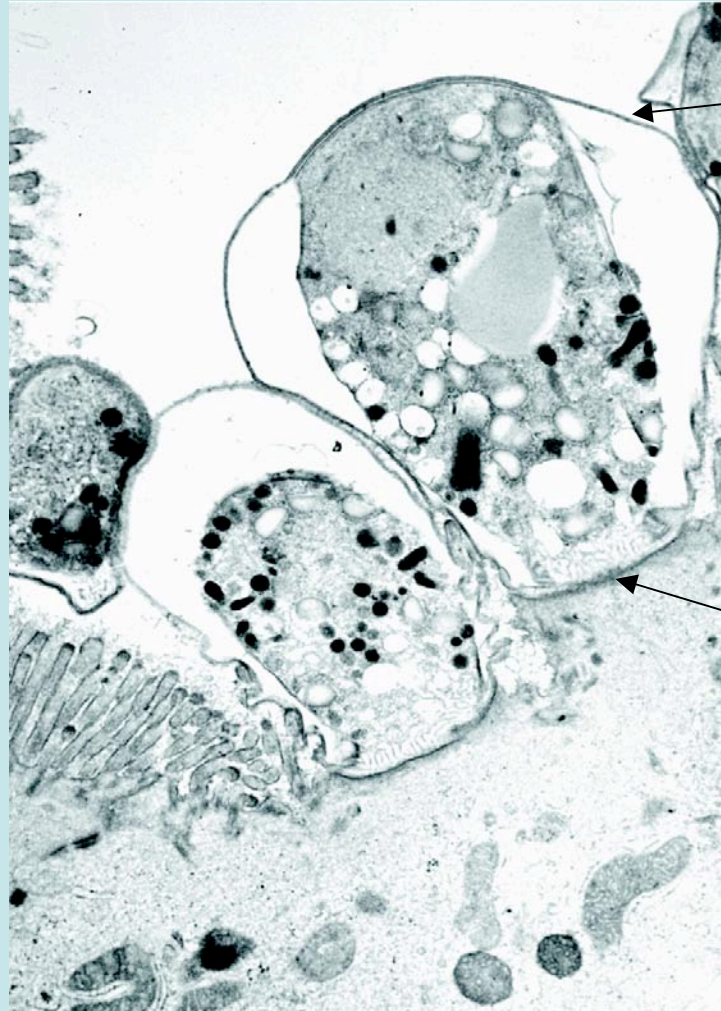
Courtesy J. Lefkowitz

Pathogenesis:

Secretory diarrhea. May produce up to 10 liters of watery stool per day! Mechanism unknown.



TEM of *Cryptosporidium parvum*

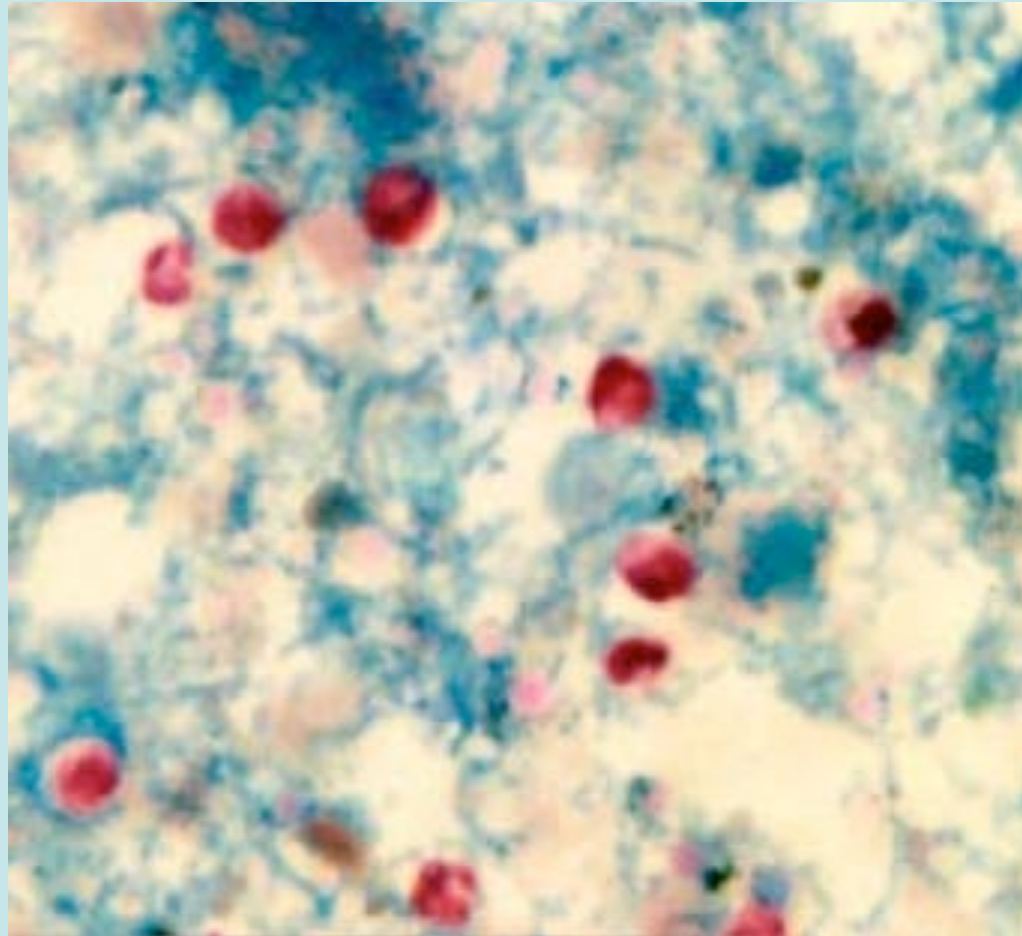


Altered host cell membrane protects parasite from all chemotherapeutic agents tested, so far.

Attachment zone

Courtesy J. Lefkowitz

Oocysts of *Cryptosporidium parvum*



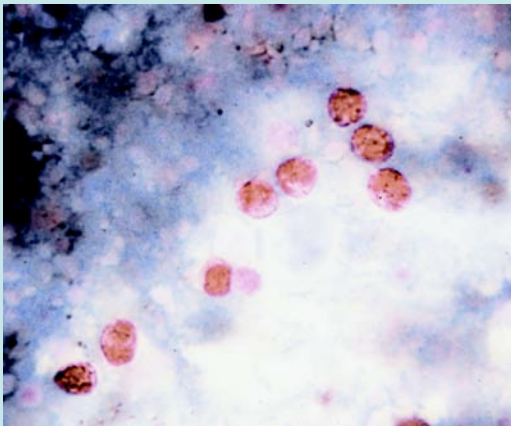
Clinical Disease:

Secretory diarrhea. In HIV(+) patients, this infection is often fatal. There are no drugs that are effective against it.

Diagnosis:

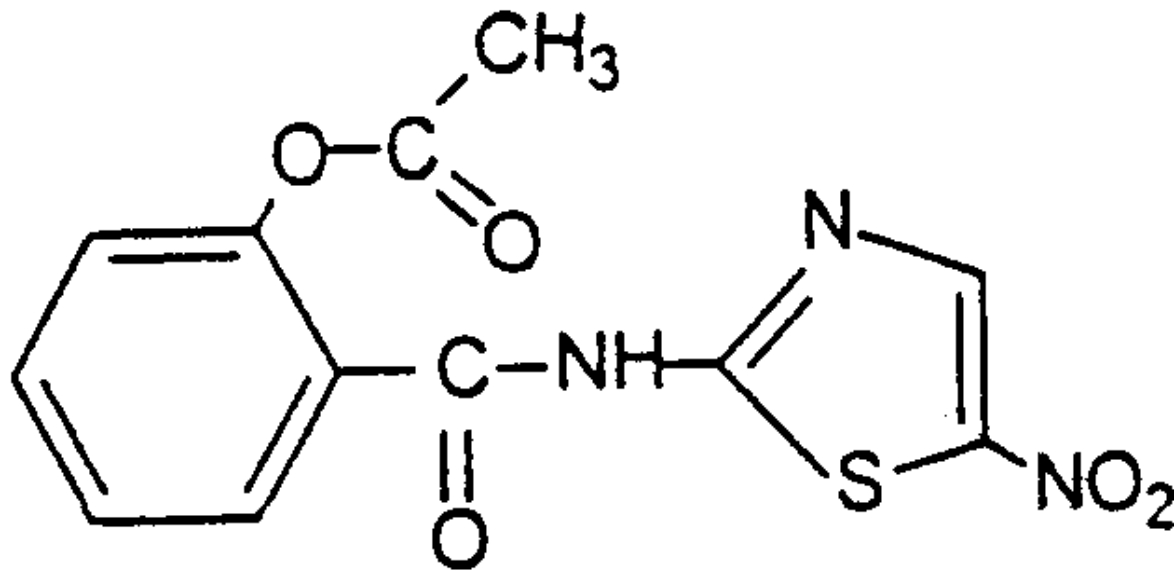
Identify oocysts on microscopic examination.

A. acid fast-stain



B. Indirect Fluorescent Antibody test

There is no approved chemotherapeutic agent for Cryptosporidium



Nitazoxanide may offer some hope

Complete Genome Sequence of the Apicomplexan, *Cryptosporidium parvum*

Mitchell S. Abrahamsen,^{1,2*†} Thomas J. Templeton,^{3†}
Shinichiro Enomoto,¹ Juan E. Abrahante,¹ Guan Zhu,⁴
Cheryl A. Lancto,¹ Mingqi Deng,¹ Chang Liu,^{1‡}
Giovanni Widmer,⁵ Saul Tzipori,⁵ Gregory A. Buck,⁶ Ping Xu,⁶
Alan T. Bankier,⁷ Paul H. Dear,⁷ Bernard A. Konfortov,⁷
Helen F. Spriggs,⁷ Lakshminarayan Iyer,⁸ Vivek Anantharaman,⁸
L. Aravind,⁸ Vivek Kapur^{2,9}

Science: 304:441-445. 2004

Medical Ecology

1. *Cryptosporidium sp.* infect a wide variety of animals (birds and mammals), many of which can also infect humans.
2. Suckling farm animals (calves, kids, lambs) are potential sources of infection for urban centers that get their drinking water from reservoirs that are surrounded by farmland (e.g., NYC).



Prevention and Control:

1. Sanitary disposal of feces



Prevention and Control (cont'd):

2. Protect public drinking water supplies from contamination with animal feces by creating buffer zones between the reservoir and the watershed.



Pepacton Reservoir

