



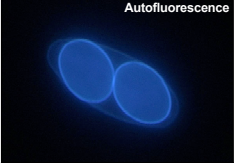

Isospora belli

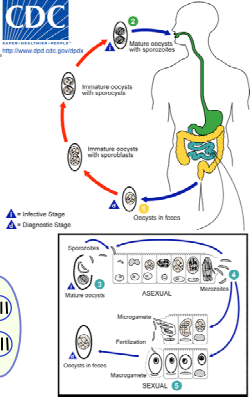
- World wide geographical distribution
- Similar life cycle to *Eimeria* (monoxenous)
 - 2 sporocysts
 - 4 sporozoites
- Usually produces a self-limiting diarrhea in immunocompetent people (can be asymptomatic)
- Only a few hundred cases described before being recognized as an opportunistic infection in immunocompromised
- Least common of the intestinal coccidia that infect humans
(*Isospora*, *Cyclospora*, *Cryptosporidium*)

Isospora belli

Autofluorescence



ASexual Cycle: Infection (Ingestive Stage) → Ingestive oocysts with sporozoites → Immature oocysts with sporoblasts → Oocysts in feces → Mature oocysts with sporozoites → Infection.

Sexual Cycle: Oocysts in feces → Macrogametes → Fertilization → Microgametes → Sexual cycle.

Isosporiasis and AIDS

The incubation period: 3-14 days.

Humans are only known hosts

Symptoms:


- Profuse, watery, nonbloody, offensive-smelling diarrhea, which may contain mucus
- Cramping abdominal pain, vomiting
- Malaise, anorexia, weight loss
- Low-grade fever
- Steatorrhea in protracted cases

Isospora infection is endemic in tropical regions, particularly of Central and South America, Africa, and Southeast Asia.

One study found positive examination findings in up to 15% of Haitians infected with AIDS.

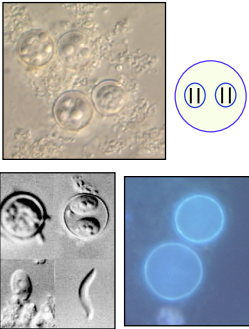
In developing countries, 8-40% of patients with AIDS are infected.

Trimethoprim-sulfamethoxazole (TMP-SMZ) is the drug of choice because it is the best-studied and most readily available agent. Many patients with AIDS are already taking this agent as prophylaxis for *Pneumocystis* infection.




Cyclospora cayetanensis

- Closely related to *Eimeria*
- Originally thought to be a blue-green algae
 - Called cyanobacterium-like body (CLB)
- First cyclosporiasis outbreak was in 1990
- Overall prevalence in US is low (1%)
- Infection most common in HIV/AIDS patients
- The main symptom is watery diarrhea, loss of appetite, weight loss, abdominal bloating and cramping, nausea, fatigue and low grade fever.
- Incubation period averages one week and illness lasts 6 weeks.




Cyclospora cayetanensis

- widely distributed, probably cosmopolitan.
- Also an important disease in travelers
- Large, multi-state food-borne outbreaks in the USA and Canada during the 1990s drew attention to this parasite.
- Associated with imported food items, specially raspberries and green leafy vegetables such as basil and mesclun lettuce.



CYCLOSPOROSIS and RASPBERRIES



Multiple foodborne outbreaks, thousands in US and Canada since 1990:
Prior 1996: mostly overseas and 3 small US outbreaks.

May 1996: 55 events (all had raspberries served) of outbreaks in US and Canada 1465 cases, 978 confirmed.

Spring 1997: 41 events, 1012 cases. Again the only common food consumed in all events was raspberries from Guatemala.

May 1998: Ontario, Canada, 315 cases

ATLANTA-Guatemalan raspberries have been fingered as the delectable vehicle of this spring's outbreaks of *Cyclospora cayetanensis*. And while the epidemiologic links to the caviar of fruit accumulated, a cousin berry was exonerated. Despite much scuttlebutt, the strawberry got a clean bill of health....

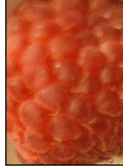
Cyclospora cayetanensis

- Countries initially identified as endemic: Haiti, Guatemala, Peru, Nepal

- If you plan to travel post-graduation:

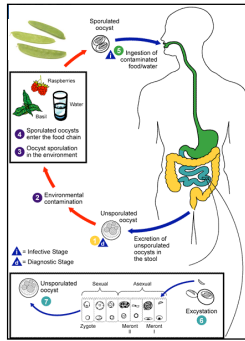
2008 countries considered endemic

Bangladesh, Brazil, Chile, China, Cuba, Dominican Republic, Egypt, Guatemala, Haiti, India, Indonesia, Jordan, Mexico, Morocco, Nepal, Nigeria, Pakistan, Peru, Puerto Rico, Romania, Saudi Arabia, Tanzania, Thailand, Turkey, Venezuela, Viet Nam, Zimbabwe



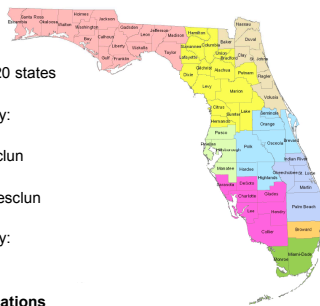
Cyclospora Life Cycle

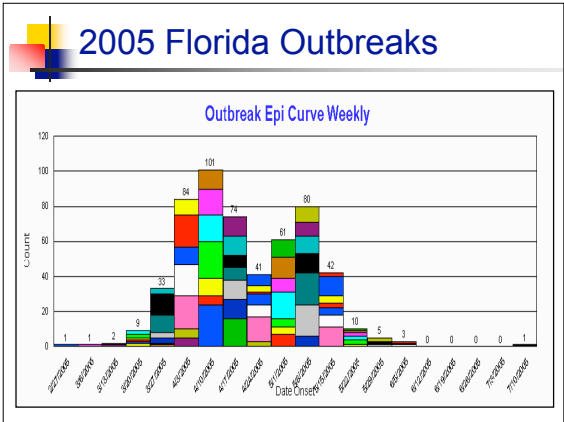
- Fecal-oral transmission
- Sporulation: 5-11 days
 - 2 sporocysts
 - 2 sporozoites
- Contaminated food or water is the common source of oocysts
- Oocysts do not survive desiccation well
- Potentially stay moist on fresh fruit and vegetables. (22°C - 32°C)



Cyclosporiasis

- 1996 - major outbreak in 20 states affecting 1465 people.
- 1996 - Palm Beach County: raspberries
- 1997 - Leon County: mesclun lettuce
- 1997 - Orange County: mesclun lettuce
- 1999 - Palm Beach County: various fruits
- 2004 - total cases 9
- 2005 - 592 - sporadic locations





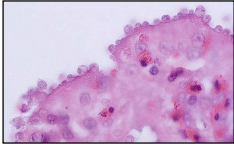
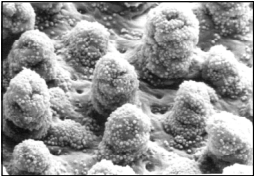
Clinical symptoms

- Incubation period: 2-14 days
- Watery and profuse diarrhea, abdominal cramps, nausea, vomiting, weight loss and low-grade fever.
- Self-limited disease in immuno-competent individuals
- Prolonged duration in immuno-compromised host. Degree of immunodeficiency correlates with severity:
 - Self-resolving disease
 - Chronic diarrhea over months (<50 CD4 count)
 - Fulminate diarrhea
- Malabsorption can contribute to the wasting syndrome in AIDS patients.
- Bile duct infection can produce jaundice.

Prevalence:
 Non-AIDS: 4.9% (developed countries); 7.9% (underdeveloped countries)
 AIDS: 14% (developed countries); 24% (Underdeveloped countries).
 Mortality: 80%


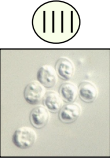
Cryptosporidium parvum

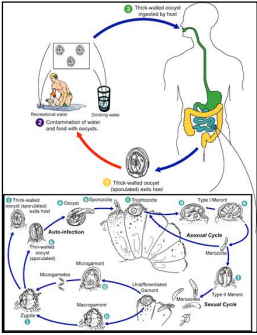
- Cosmopolitan distribution
- Obligate intracellular parasite
- First Human case reported in 1976
- Usually produces a self-limiting diarrhea in immunocompetent people
- Persistent and **life threatening** in immunocompromised people
- Fairly common parasite - species can infect birds, reptiles, fish and mammals
- Considered a **zoonosis**

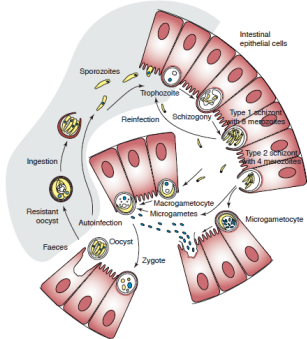
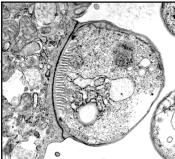
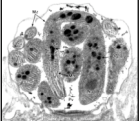
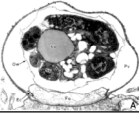
Cryptosporidium Life Cycle

- Oral-fecal transmission
- Sporulation:
 - 0 sporocysts
 - 4 sporozoites - "naked"
- Contaminated water (or food) is the common source of oocysts
- **Sporulated oocysts are shed**
- Autoinfection!

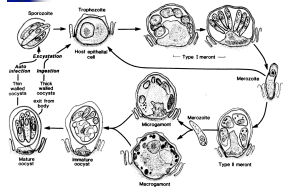
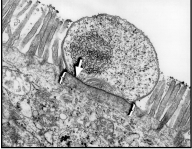
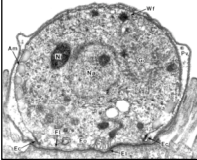





Life cycle forms

Unique feature - feeder organelle

Confined to apical surface of epithelial cell
Resides within a parasitophorous vacuole
Extracytoplasmic

Feeder organelle membrane - presumably for uptake of nutrients

Cryptosporidium parvum

TREMS in Parasitology

- Share features with other apicomplexa: micronemes, rhoptries and dense granules, pellicle
- **Do not have:** classical mitochondria (remnant organelle), subpellicular microtubules, conoid
- Intracellular but extracytoplasmatic, feeder organelle
- Genome sequenced 2004
- More closely related to Gregarines than "coccidia"
- Will the gregarines return to biology forefront as a good model system?

Comparison: Host-parasite interactions

(a) Mycozoitosis
(e.g. dinoflagellates and colpodeids)

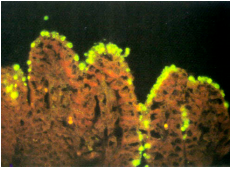

(b) Transmembrane
(e.g. gregarines)

(c) Epicellular
(e.g. Cryptosporidium spp.)

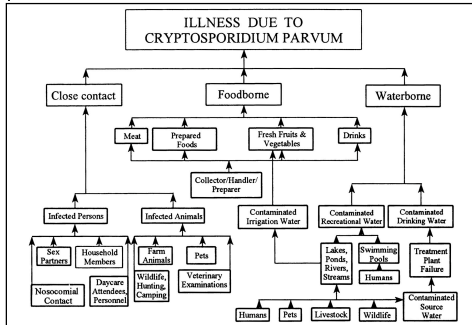
(d) Intracellular
(e.g. coccidia)

Factors favoring waterborne Cryptosporidiosis

- small size of oocysts (4-5 μm)
- reduced host specificity and monoxenous development
- close associations between human and animal hosts
- large number of oocysts excreted (up to 100 billion per calf per day)
- low infective dose (<30)
(as few as 10 oocysts in human volunteers!)
- robust oocysts; resistant to chlorine

Potential Hazards



Diagnosis

- Diagnostic stage is the cyst
- Demonstration of oocysts in feces
- Morphological features
- All three acid-fast stain
- Autofluorescence



Diagnosis

- In the US, on average....medical students receive only about 6 hours of parasitological training during medical school.
- More than 400 different parasitic species infect humans (excluding arthropods)
- Can your physician diagnose a parasitic infection such as *Cyclospora*?, *Cryptosporidium*?, *Giardia*?
- How many infections go undiagnosed?
- Immunocompromised patients require rapid diagnosis

