

## Protozoa Transmitted via Food (and Water)

PHR 250

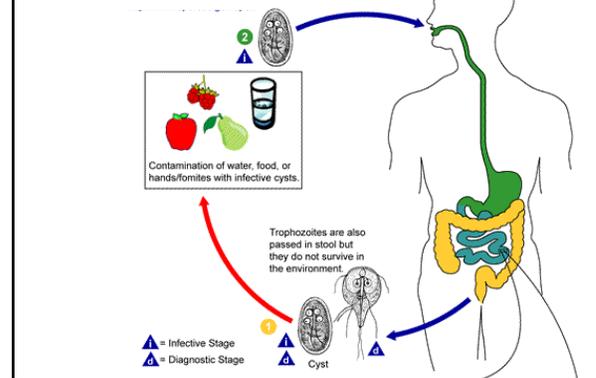
## PROTOZOA—life cycles

- \*Trophozoites (merozoites, tachyzoites) — active, feeding, dividing (+ bradyzoites)
- \*Cysts — inert transmission form (exception: *Toxoplasma*)
- \*Gamonts → zygote → oöcyst (sporozoites)

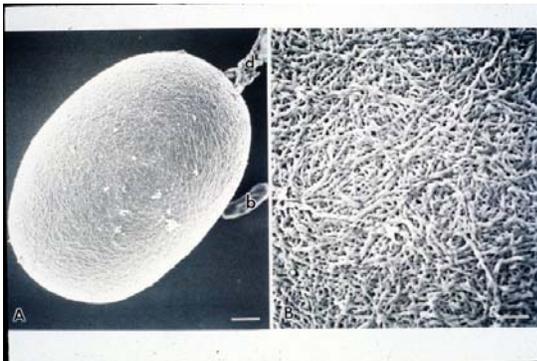
### *Giardia lamblia* (= *duodenalis* = *intestinalis*)

- \*Leading protozoan cause of foodborne and waterborne disease in US
- \*CDC, '98–'02: 3 foodborne outbreaks, 119 cases; '03–'04: 2 waterborne outbreaks, 14 cases
- \*Spheroid cysts 9–12 µm long

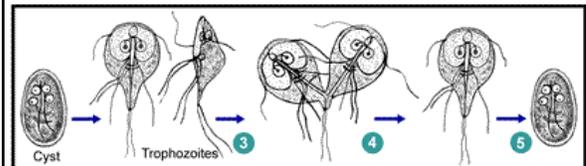
### Giardiasis



### *Giardia* cyst



### Giardiasis



### *Giardia trophozoite*



### *Giardia lamblia*

- \*Incubation 7–10 days; characteristic diarrhea from noninvasive colonization of upper small intestine may persist for weeks if untreated; asymptomatic infections very common.
- \*Reservoirs: humans, beavers, cattle, and other animals.

### *Giardia lamblia* vehicles

- \*Unfiltered surface water (*Giardia* is fairly resistant to chlorine)
- \*Drinking water recontaminated with sewage
- \*Fruits, vegetables, salads, and other foods subject to direct or indirect fecal contamination

### *Cryptosporidium parvum*

- \*Oöcysts from humans, cattle, other domestic & wild species (human-specific species: “*C. hominis*”)
- \*Small (4–6  $\mu\text{m}$ ), tough, chlorine-resistant

### *Cryptosporidium parvum*

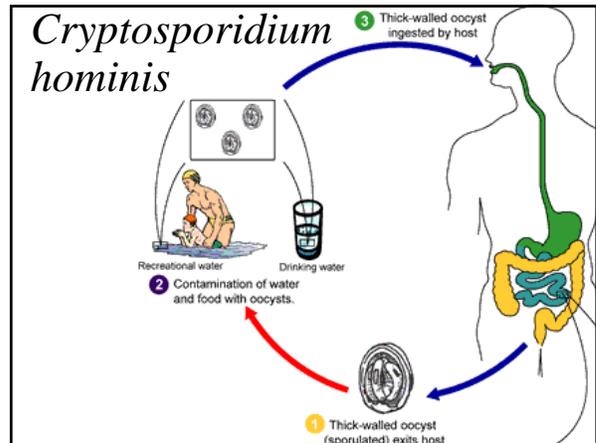
- \*Largest outbreak of waterborne disease in history (Milwaukee, 1993, ca. 403,000 cases, but only one waterborne U.S. outbreak during '03–'04)

### *Cryptosporidium parvum*

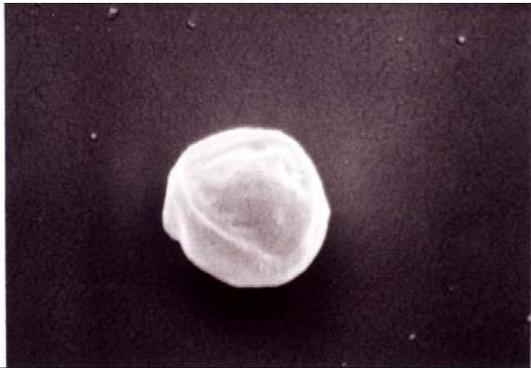
- \*Outbreaks from apple juice (cider) 1993 & 1996, and raw milk and a few other food vehicles
- \*CDC ('98–'02): 4 outbreaks, 130 cases
- \*FoodNet (2005): ~8850 cases

## *C. parvum, C. hominis*

\*Incubation ~1 week, profuse diarrhea usually <30 days (shedding 2–6 months); intracellular parasitism; treatment is rehydration.



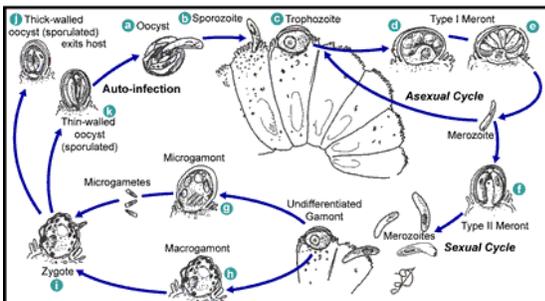
## *C. parvum* oocyst



## *C. parvum* excysting



## *Cryptosporidium parvum* or *C. hominis*



## *C. parvum* sporozoites



### *C. parvum* or *C. hominis*

\*Cryptosporidiosis is diagnostic of AIDS in HIV-positive persons & will generally persist (with intermittent symptoms) for life.

### *C. parvum* or *C. hominis*

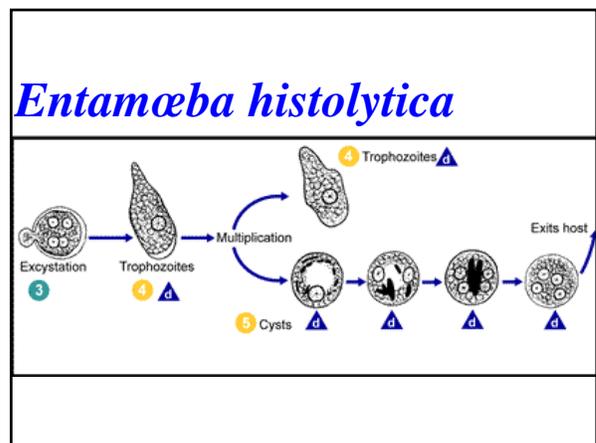
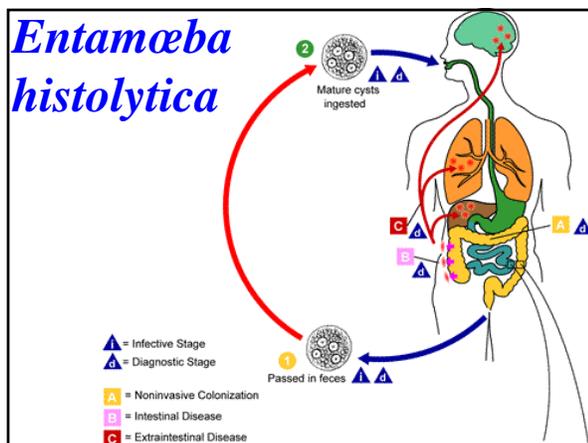
\*Concern for cryptosporidiosis (especially waterborne) is evoking stringent measures in the U.S. and will have a significant impact on agriculture involving ruminants.

### *Entamoeba histolytica*

\*Once a frequent cause of waterborne disease in the US, now fairly rare here  
\*Continues to be a very significant threat in the poorer countries.

### *Entamoeba histolytica*

\*Causes amebic dysentery, sometimes abscesses of liver or other organs (trophozoites are invasive).  
\*Human-specific; transmitted via fecally contaminated water or food.



## *Entamoeba histolytica*



## *Entamoeba histolytica*



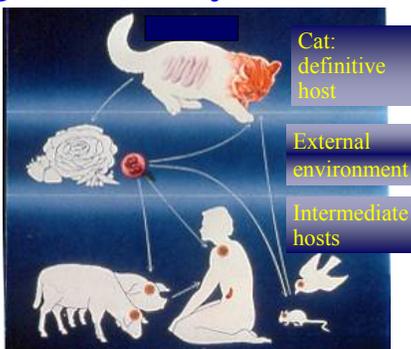
## *Toxoplasma gondii*

- \*Outbreaks (acute, foodborne) rare
- \*CAST: ~2090 cases, 42 deaths, \$2.6 billion/yr ( $\times 1/2$ ?) from congenital blindness, hydrocephalus, retardation

## *Toxoplasma gondii*



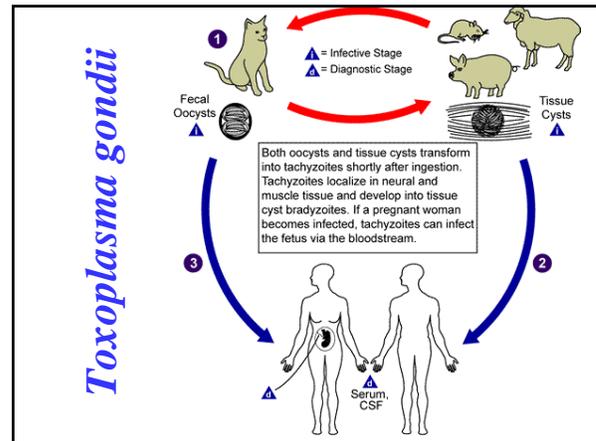
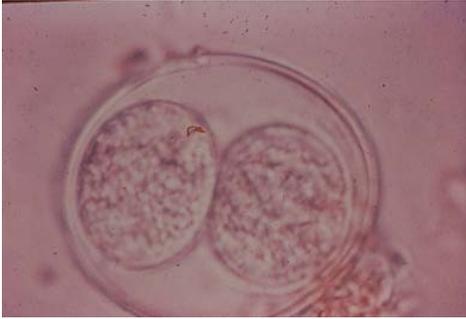
## *T. gondii* life cycle



## *Toxoplasma gondii*

- \*Cats are definitive hosts, usually infected by eating infected birds or rodents; oöcysts (not immediately infective) in cat feces for up to 3 weeks contaminate animal feed, garden vegetables, other foods, water.

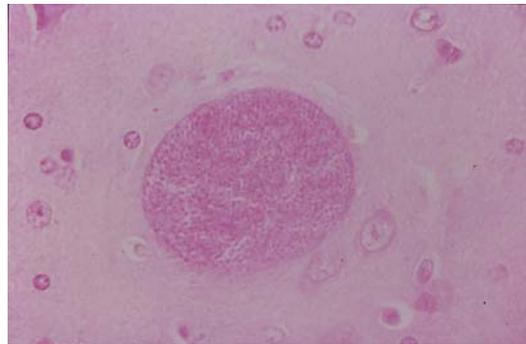
## *T. gondii* oocyst



## *Toxoplasma gondii*

- \*Tissue cysts (bag of **bradyzoites**) in pork, mutton, beef — killed by cooking or irradiation; freezing does not eliminate them completely.

## *T. gondii* tissue cyst



## *Toxoplasma gondii*

- \***Tachyzoites** may encyst in various tissues (often CNS in humans); cellular immune response causes encystation as bradyzoites; tissue cysts well tolerated in humans but may be reactivated if immunity is later impaired.

## *Cyclospora cayentanensis*

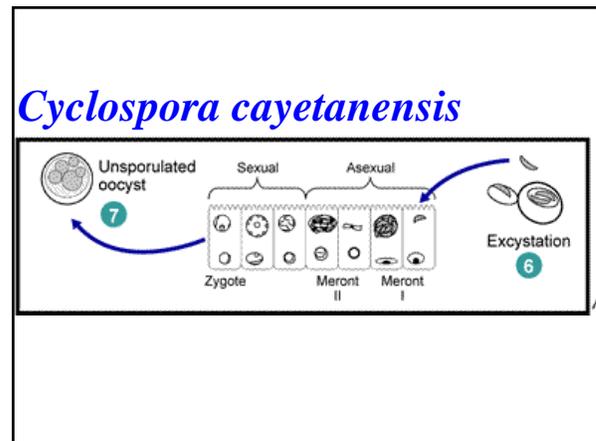
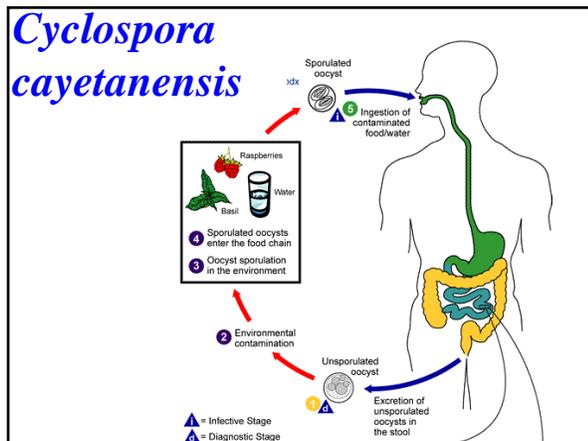
- \*Human-specific; delayed maturation (days to weeks under favorable conditions) of oöcysts in feces makes person-to-person transmission unlikely.
- \*Fairly common in parts of Latin America and Asia

## *Cyclospora cayetanensis*

- \*Rare in U.S., but caused an extensive (nationwide + Canada) outbreak in May–June of 1996, eventually attributed to raspberries imported from Guatemala; again in 1997; embargoed in U.S. (but not Canada) in 1998; back in 1999?

## *Cyclospora cayetanensis*

- \*CDC ('98–'02): 9 outbreaks, 325 cases
- \*FoodNet (2005): ~450 cases



## *Cyclospora cayetanensis*

- \*Presently, there are just four Guatemalan farms that may be permitted to export raspberries to the U.S., contingent on fecal testing of the farm workers.
- \*No positive fecal tests had resulted, at last report.

## Summary

- \*Limited look at foodborne protozoa
- \*Five agents discussed; three species (*Cryptosporidium hominis*, *Cyclospora cayetanensis* & *Entamoeba histolytica*) are human-specific & transmitted by a fecal-oral route.

## Summary

- \*Others all transmitted zoonotically at least some of the time, either via infected animal feces or tissue
- \*Human feces also important sources of *Cryptosporidium hominis* (& *parvum*?) oöcysts and *Giardia lamblia* cysts that may be transmitted to humans via water or food.