Gastrointestinal parasitology 1

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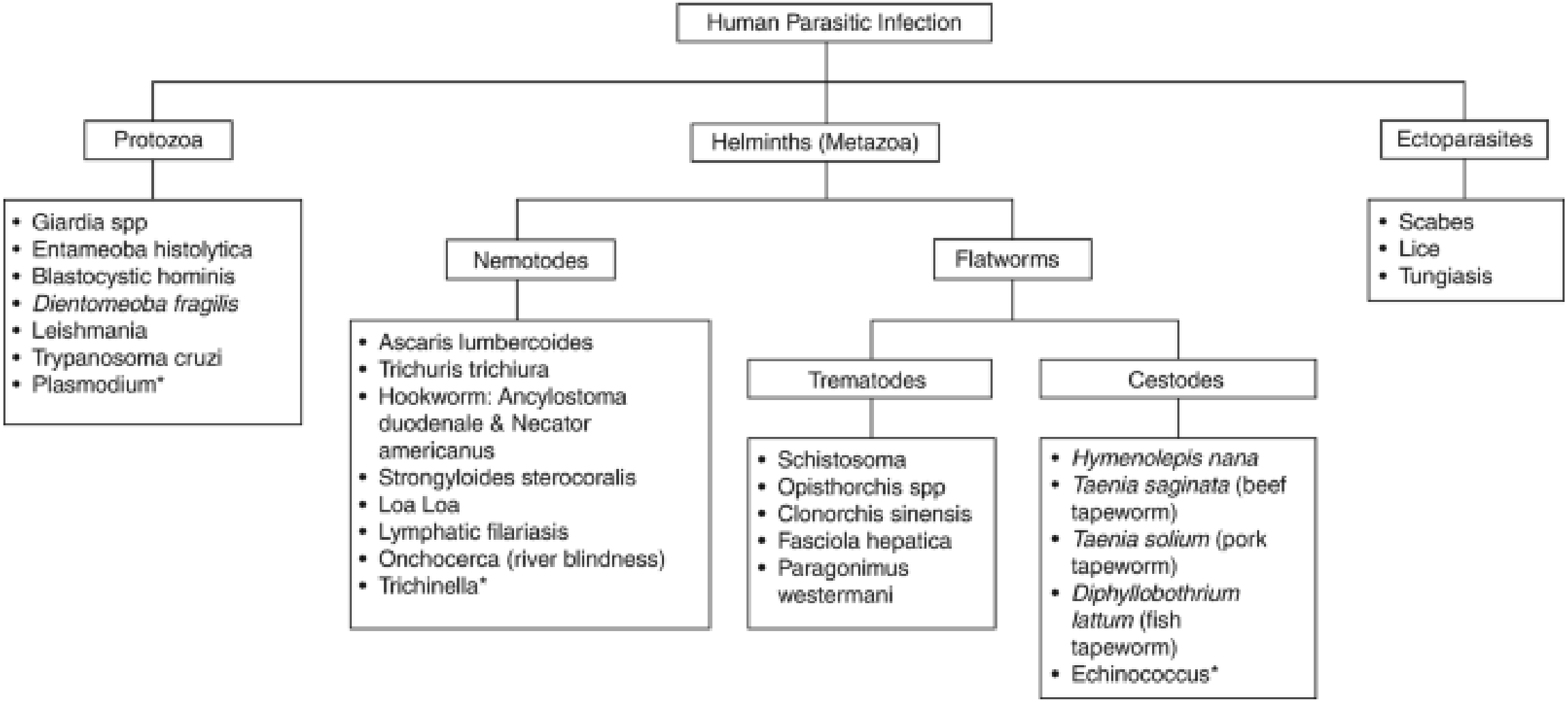
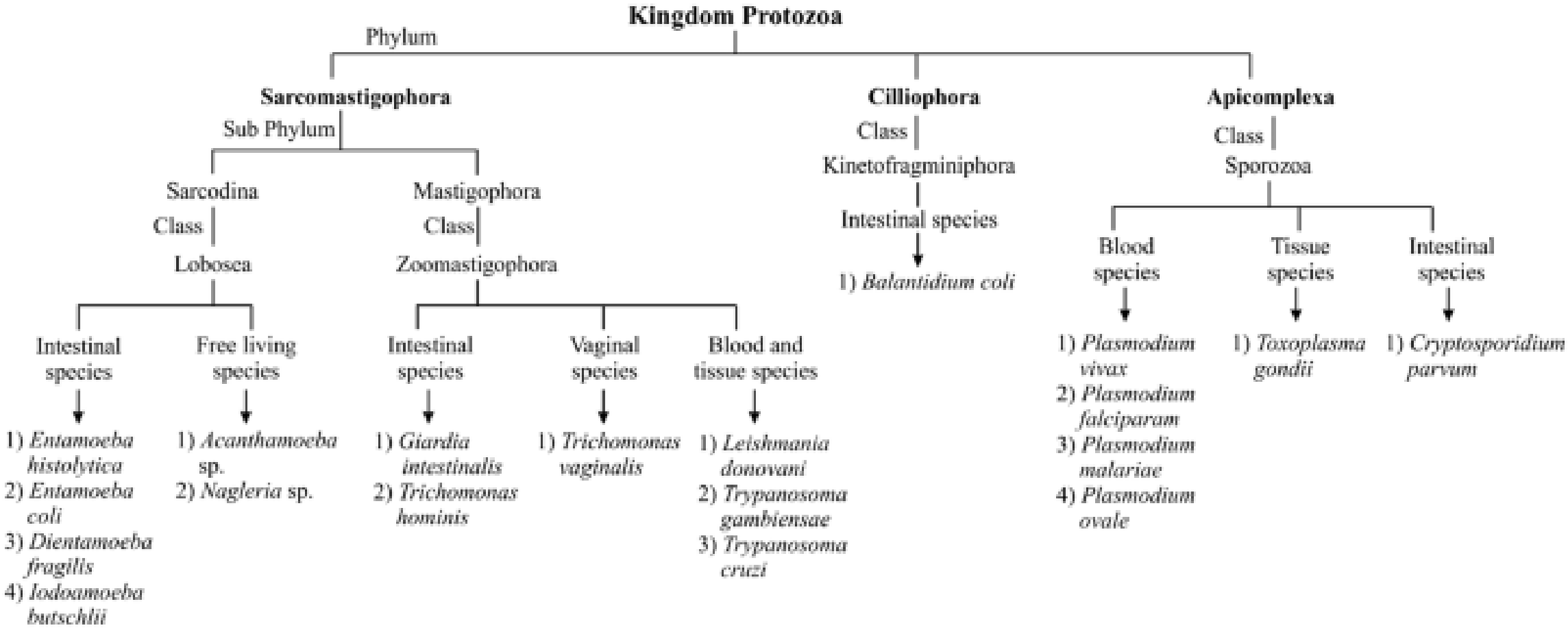


Shaughnessy, M., Frosch, A., Stauffer, W. (2020). Parasitic Infections. In: Annamalai, A. (eds) Refugee Health Care. Springer, Cham. https://doi.org/10.1007/978-3-030-47668-7_6



Bandyopadhyay, P.K., Das, N.R., Chattopadhyay, A. (2022). Protozoan Parasites. In: Biochemical, Immunological and Epidemiological Analysis of Parasitic Diseases . Springer, Singapore. https://doi.org/10.1007/978-981-16-4384-2_2

Intestinal Parasites

- Human parasites include **parasitic protozoa** and **parasitic helminths.**
- Parasitic diseases are strongly associated with **poverty**, poor sanitation, and limited access to health care.
- Protozoan and helminthic infections may involve different organ systems, including **intestinal infections** and **blood/tissue infections**.
- Important intestinal parasites include **intestinal protozoa**, such as ***Giardia, Entamoeba, Cryptosporidium, Cyclospora***, and intestinal helminths, including **nematodes, trematodes, and cestodes**.

Classification of Intestinal Protozoa

- **Protozoa are unicellular eukaryotes**.
- Protozoa are divided into four groups based on **locomotion and mode of reproduction**: **flagellates, amebae, sporozoa, and ciliates**.
- **Flagellates** have one or more whip-like **flagella**; the important intestinal flagellate is ***Giardia***.
- **Amebae** use **pseudopodia** to move; intestinal disease is represented by ***Entamoeba*** species.
- **Sporozoa** undergoe sexual and asexual reproductive phases; intestinal examples include ***Cryptosporidium*** and ***Cyclospora***.
- **Ciliates** have cilia distributed in rows or patches; ***Balantidium coli*** is a giant intestinal ciliate of humans and pigs.
- **Microsporidia** are intracellular spore forming parasites (now classified as fungi) and may cause intestinal disease in **immunocompromised patients.**

Classification of Intestinal Helminths

- Human helminths are mainly **nematodes** and **platyhelminths**
- **Nematodes** are elongated, tapered at both ends, round in cross-section, and unsegmented.
- Nematode infections are usually acquired by ingestion of **eggs or larvae**, or by **skin penetration**
- **Platyhelminths** are flatworms and include: **Trematoda**, or flukes, and **Cestoda**, or tapeworms.
- **Trematodes** or flukes are usually flattened and leaf shaped commonly acquired by ingestion of **metacercariae**, while schistosome cercariae directly penetrate the skin.
- **Cestodes**, or tapeworms, are flat and ribbon-like, with segments called **proglottids**; the **scolex** attaches to the intestinal wall.
- Adult tapeworms absorb nutrients directly from the host because they have **no mouth or gut**.

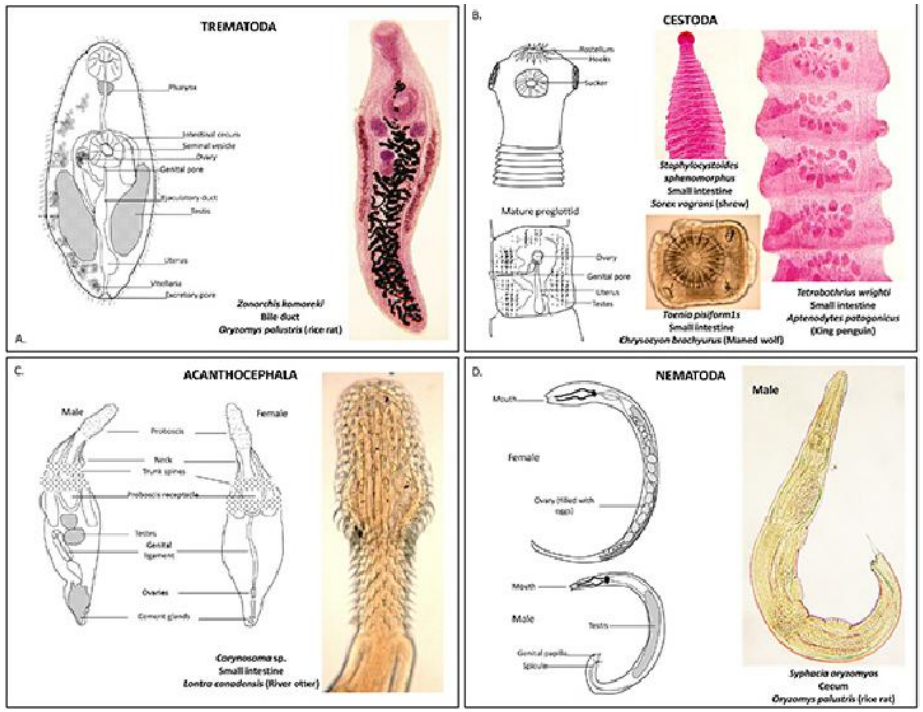
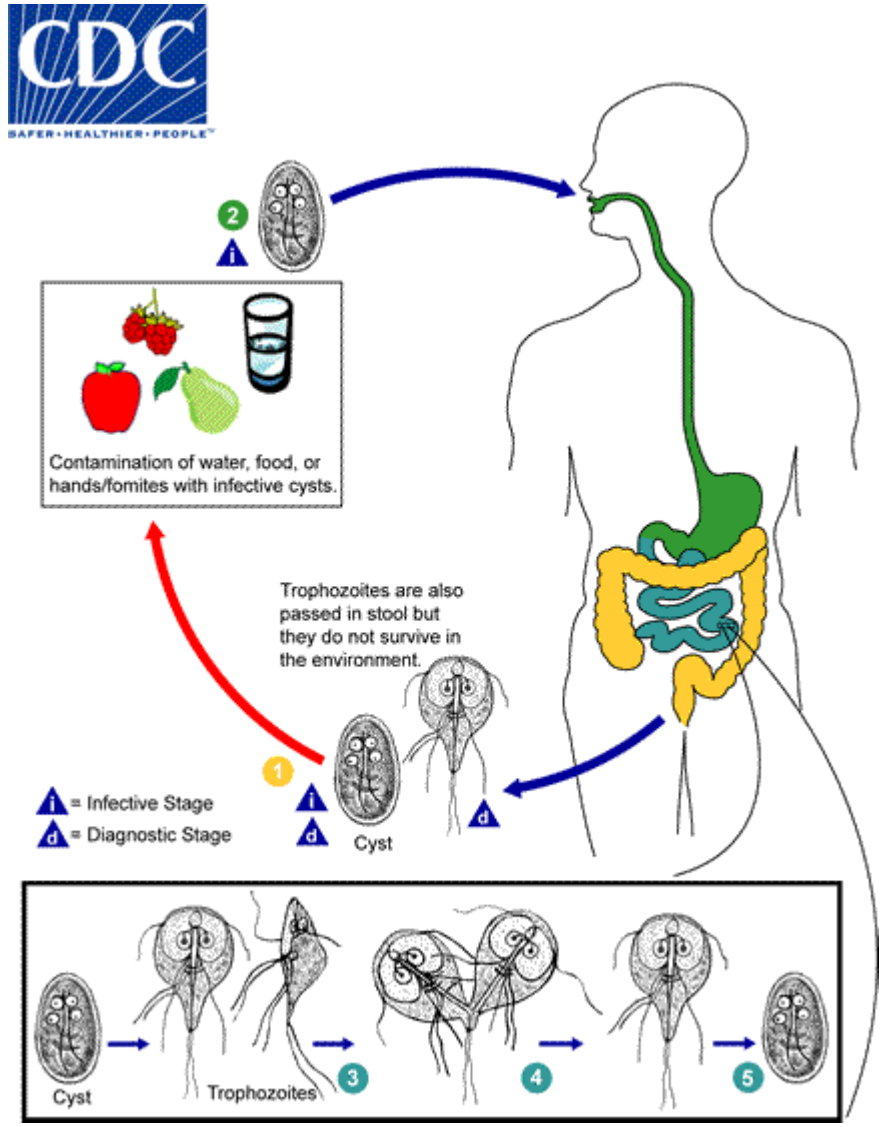


TABLE 46-2 Synopsis of Protozoan Infections by Organ System

Parasite/Disease	Site of Infection	Mechanism of Infection	Diagnosis	Treatment	Geographic Area
Intestinal protozoa					
G. lamblia (flagellate) Giardiasis	Small intestine	Ingest cysts in water, not killed by normal chlorination	Stool exam for O&P; EIA; DFA assay	Metronidazole or nitazoxanide	Ubiquitous: campers, ski resorts, dogs, wild animals, especially beavers
E. histolytica (ameba) Amebiasis	Colon; liver; other organs	Ingest cysts from fecal contamination of water or food or oral/anal behaviors	Stool exam for O&P; EIA for antibodies and antigen	Iodoquinol, or paromomycin; metronidazole for mild, moderate, severe intestinal disease	Worldwide wherever fecal contamination occurs
Cryptosporidium (sporozoa) Cryptosporidiosis	Small intestine; respiratory tract	Ingest oocysts, fecal contamination	Stool exam/modified acid-fast staining; EIA; DFA assay	Nitazoxanide for immunocompetent	Ubiquitous, especially in cattle-raising areas
Cyclospora (sporozoa) Cyclosporiasis	Small intestine	Oocysts from fecal contamination of water, fresh produce	Stool exam/modified acid-fast staining, UV fluorescence microscopy	Trimethoprim–sulfamethoxazole	Worldwide, tropics, subtropics

Giardia lamblia

- ***G. lamblia***, also referred to *as* ***Giardia duodenalis*** or ***Giardia intestinalis***, is the causative agent of **giardiasis**.
- It is the only common pathogenic protozoan found in the **duodenum and jejunum** of humans.
- **Giardia** exists in two forms: the **trophozoite** and the **cyst forms**.



Morphology and Identification

- The trophozoite of ***G. lamblia*** is a **heart-shaped organism**, has **four pairs of flagella**, and is approximately **15 µm** in length.
- A large concave **sucking disk** on the ventral surface helps the organism to adhere to **intestinal villi**.
- In the colon, they typically **encyst**, and the cysts are passed in the stool.
- Cysts are **ellipsoid, thick-walled, highly resistant**, and **8–14 µm** in length.
- They contain **two nuclei as immature forms** and **four as mature cysts**.

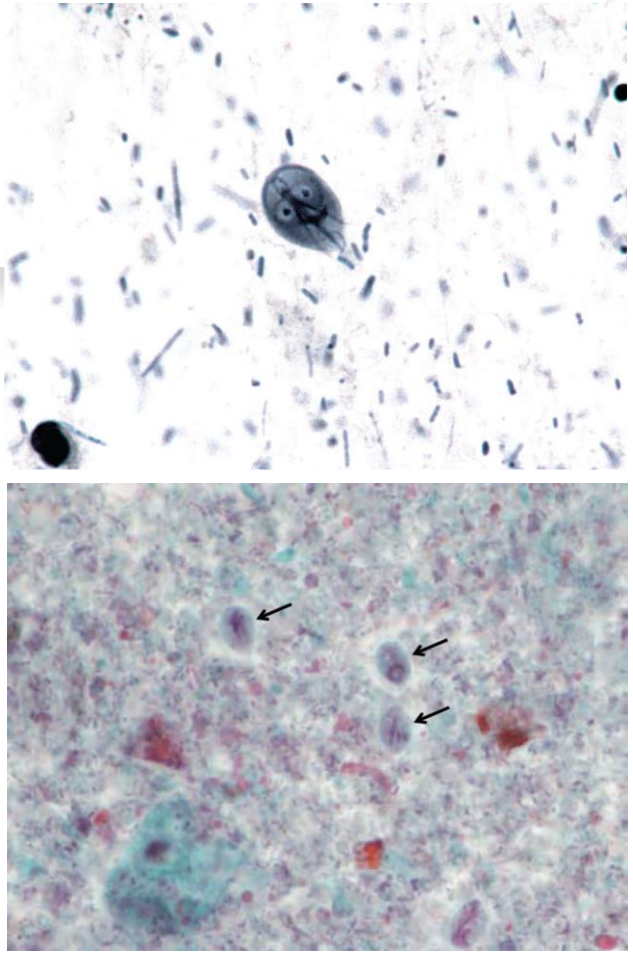


FIGURE 46-1 *Giardia lamblia*. **A:** Trophozoite (12–15 µm). (Used with permission from Sullivan J: *A Color Atlas of Parasitology*, 8th ed. 2009.) **B:** Cyst (11–14 µm). (Courtesy of D. Petrovic, Microbiology Section, Clinical Laboratories, UCSF.)

Pathogenesis and Clinical Disease

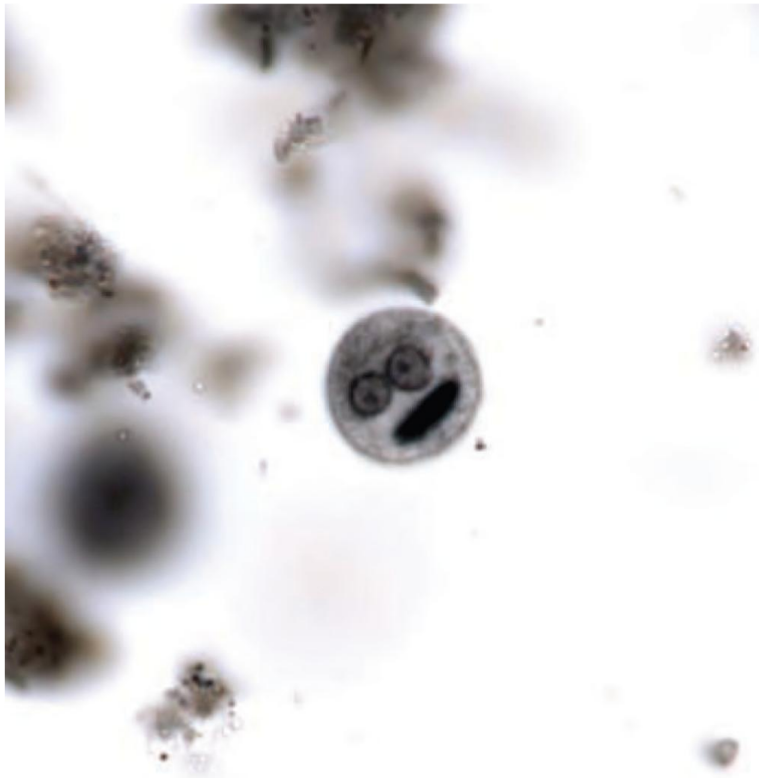
- ***G. lamblia*** is usually only weakly pathogenic for humans.
- Cysts may be found in large numbers in the stools of entirely **asymptomatic persons**.
- In some persons parasites attached to the bowel wall may cause **irritation and low-grade inflammation** of the duodenal or jejunal mucosa.
- Acute or chronic diarrhea associated with **crypt hypertrophy, villous atrophy or flattening, and epithelial cell damage may result** .

Symptoms, Diagnosis, and Epidemiology

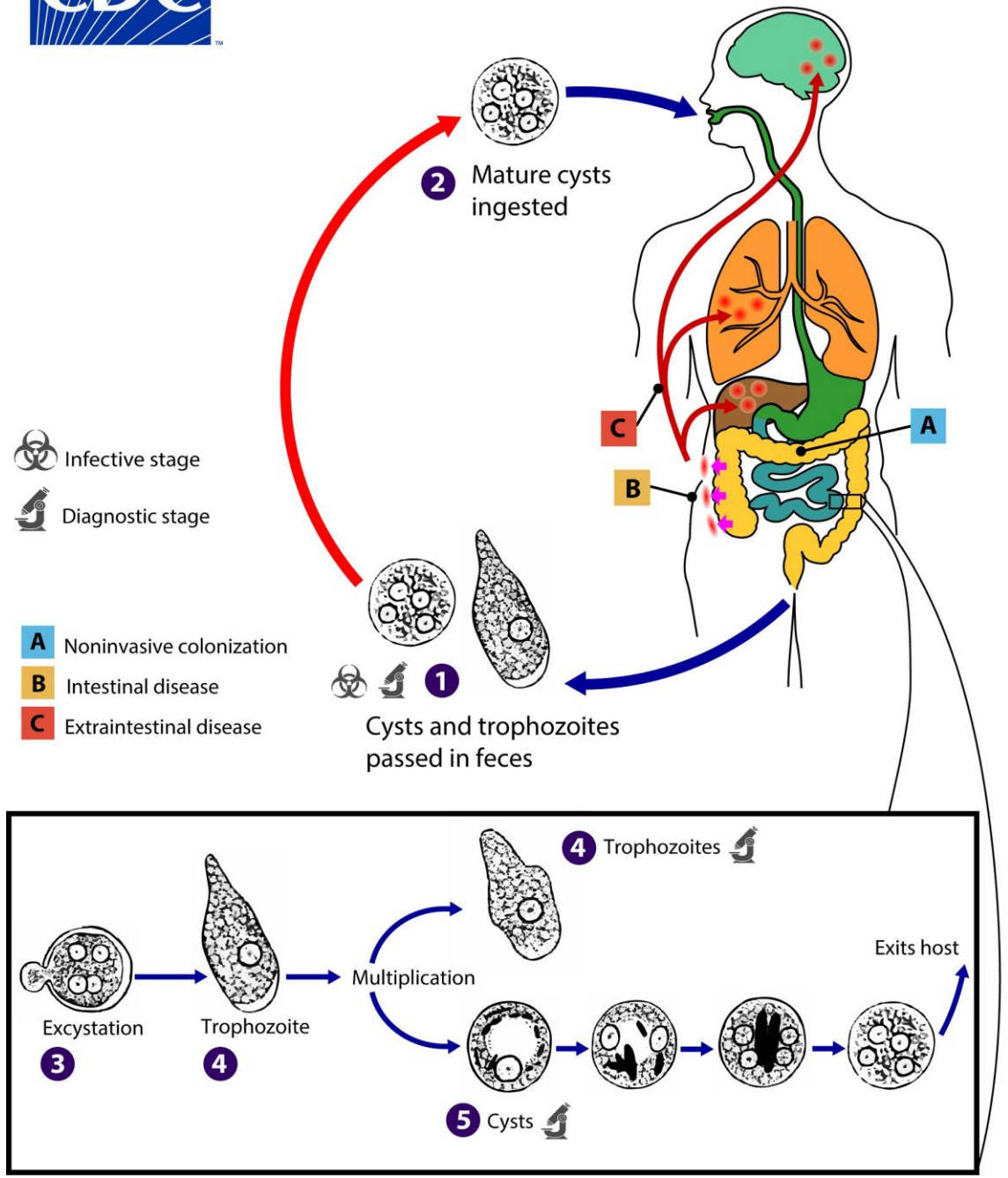
- Stools may be **watery, semisolid, greasy, and foul smelling** .
- Symptoms of **weakness, weight loss, abdominal cramps, distention, and flatulence** may continue for long periods.
- Collecting **multiple stool samples over several days** is recommended to increase the likelihood of cyst detection.
- Humans are infected by ingestion of **fecally contaminated water or food containing *Giardia* cysts** or by direct fecal contamination.
- Cysts can survive in water for up to **3 months**.

Entamoeba histolytica

- ***E. histolytica*** cysts are present only in the **lumen of the colon** and in **mushy or formed feces** and range in size from **10 to 20 µm**.
- The cyst may contain a **glycogen vacuole** and **chromatoid bodies** with characteristic rounded ends.
- After nuclear division a **quadrinucleated cyst**, and the chromatoid bodies appear and glycogen vacuoles disappear.
- Diagnosis in most cases rests on the characteristics of the cyst.

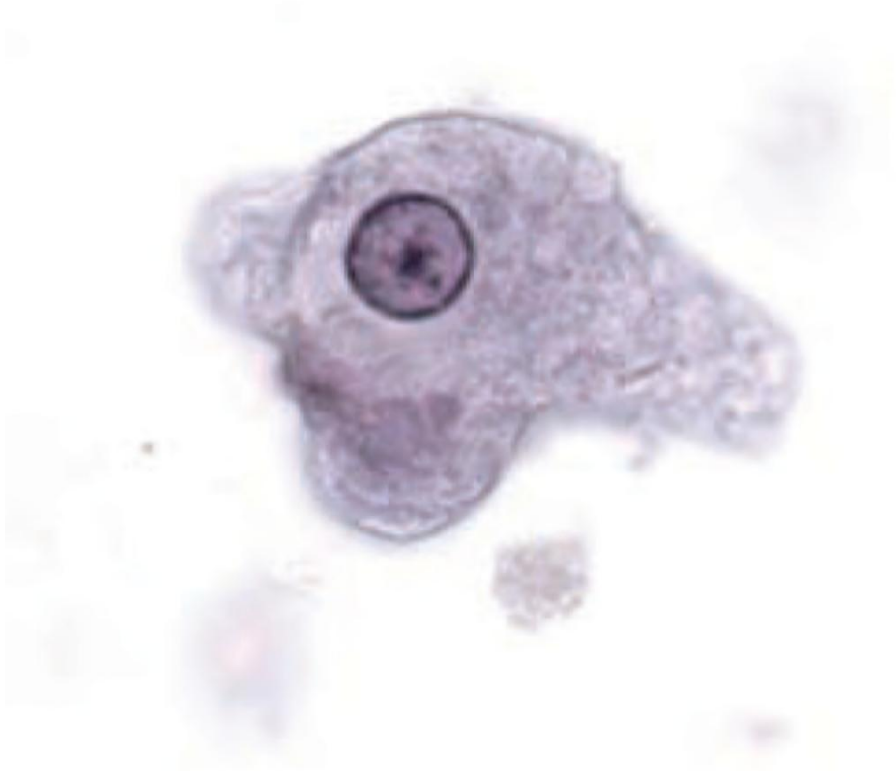


Amebiasis


Infective stage
Diagnostic stage
A Noninvasive colonization
B Intestinal disease
C Extraintestinal disease
1 Cysts and trophozoites passed in feces
2 Mature cysts ingested
A
B
C
Excystation
3
Trophozoite
4
Multiplication
4 Trophozoites
5 Cysts
Exits host

Trophozoite and Diagnostic Clue

- Trophozoites usually appear only in **diarrheic feces** in active cases and survive for only a few hours.
- The **ameboid trophozoite** is the only form present in tissues.
- The cytoplasm has two zones, a **hyaline outer margin** and a **granular inner region**.
- The granular inner region may contain **red blood cells**, which is **pathognomonic**.
- Trophozoites, especially with red blood cells in the cytoplasm, found in **liquid or semi-formed stools** are pathognomonic.



Invasive Amebiasis

- Disease results when the trophozoites of ***E. histolytica*** invade the intestinal epithelium.
- They form discrete ulcers, afterwhich the multiplying amebae spread, undermining the mucosa and producing **“flask-shaped” ulcer** of primary amebiasis.
- Secondary intestinal lesions may develop, usually in the **cecum, appendix, or nearby portion of the ascending colon**.

https://www.pathologyoutlines.com/topic/colonamebic.html

Clinical Disease, Extraintestinal Spread, and Diagnosis

- **Extreme abdominal tenderness, fulminating dysentery, dehydration, and incapacitation in serious disease** .
- Less acute disease may include episodes of **diarrhea, abdominal cramps, nausea and vomiting**, and an urgent desire to defecate.
- Extraintestinal infection is metastatic and rarely occurs by direct extension from the bowel.
- By far the most common form is **amebic hepatitis or liver abscess,** observed on abdominal imaging.
- A characteristic **“anchovy paste”** is produced in the abscess and seen on surgical drainage.
- Pleuropulmonary abscess, brain abscess, and necrotic lesions on the perianal skin and genitalia have also been observed.
- Serologic tests in these cases are usually **strongly positive**.

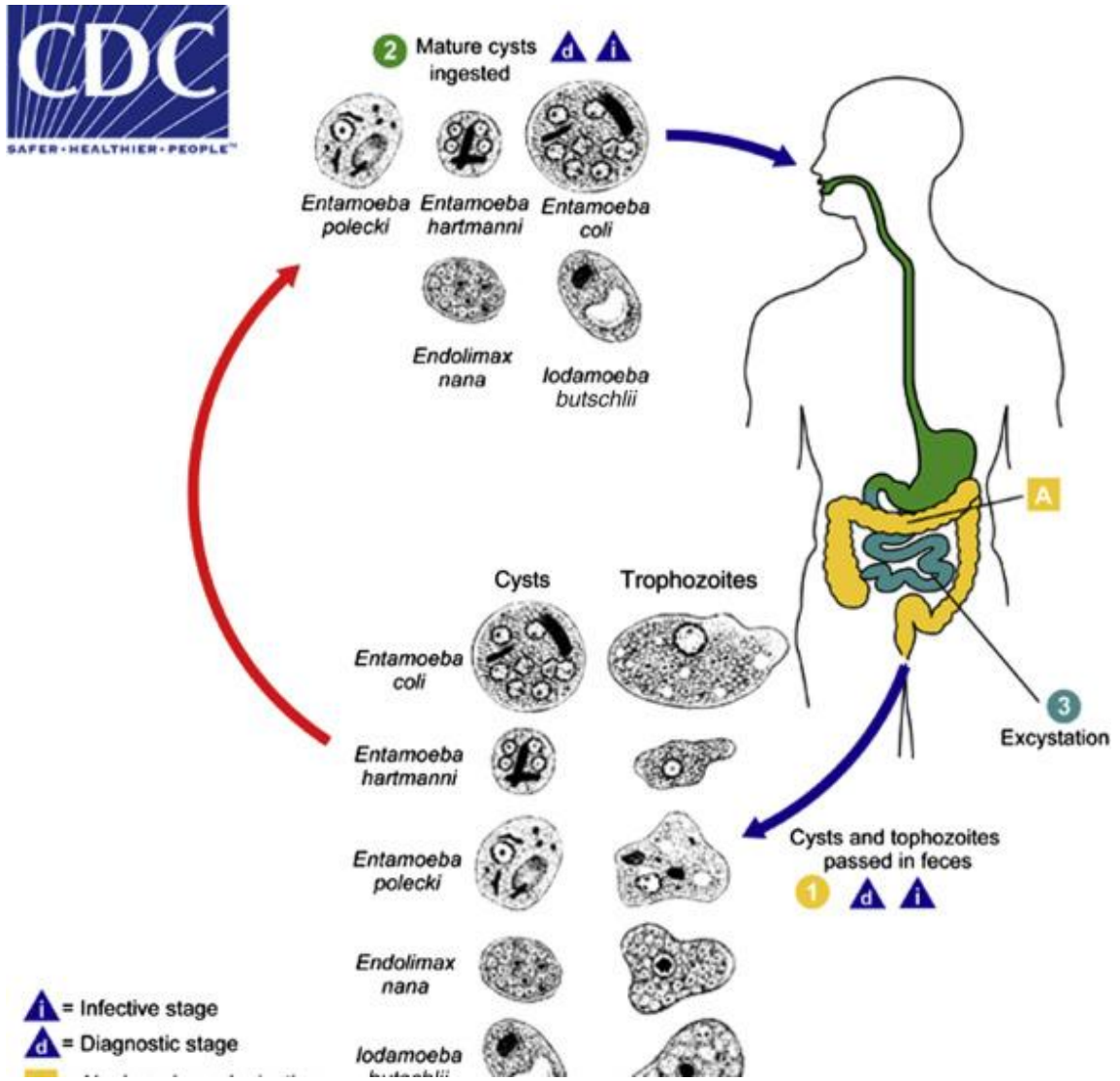
Arivalagan B, Vashisht R, Sharma A, *et al*
Multiple amoebic liver abscesses with characteristic anchovy sauce aspirate
BMJ Case Reports CP 2023;**16:**e255976.

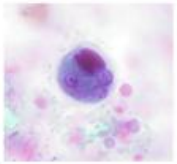
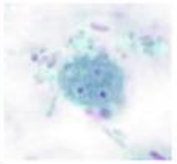
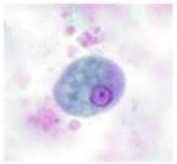
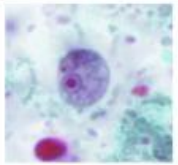
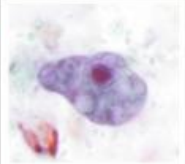
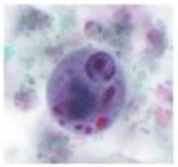
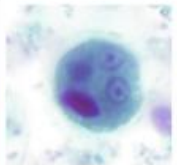
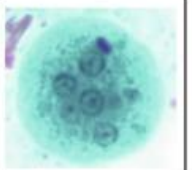
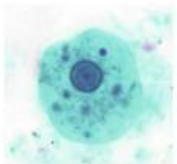
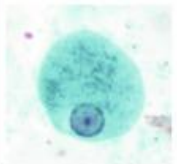
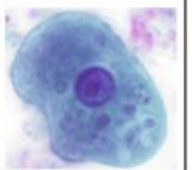
Other Intestinal Amebae: Important Differentiation

- Invasive or pathogenic ***E. histolytica*** is now considered a species distinct from the more common lumen-dwelling nonpathogenic commensal species, ***Entamoeba dispar***.
- The name ***E. histolytica*** is reserved only for the pathogenic form.
- ***E. dispar*** and the related ***Entamoeba moshkovskii*** are, distinct species, even though they are microscopically identical.
- ***E. histolytica*** must be distinguished from other intestinal ameba-like organisms because to avoid overtreatment.

Other Intestinal Amebae: Organisms and Diagnosis

- Other ameba-like organisms that are intestinal parasites of humans include ***E. coli***, which is very common; ***Dientamoeba fragilis;*** ***Iodamoeba bütschlii;*** *and* ***Endolimax nana***.
- ***Dientamoeba fragilis*** is a flagellate, the only intestinal parasite other than ***E. histolytica*** suspected of causing diarrhea and dyspepsia but is not invasive.
- **Enzyme immunoassay** kits for serodiagnosis of amebiasis when stools are often negative are available.
- EIA tests to detect amebic **antigen** in the stool are sensitive and specific *for* ***E. histolytica*** .



Species	*Entamoeba hartmanni*	*Endolimax nana*	*Dientamoeba fragilis*	*Iodamoeba buetschlii*
Cyst			Existence of cyst form is not universally accepted	
Trophozoite				
Species	***Entamoeba polecki***	***Entamoeba histolytica/ E. dispar***	***Entamoeba coli***	
Cyst				
Trophozoite				

Endolimax nana (5-10 µm)	Entamoeba hartmanni (5-10 µm)	Iodamoeba butschlii (5-20 µm)	Entamoeba polecki (9-24 µm)	Entamoeba coli (15-20 µm)	Entamoeba histolytica/ dispar (12-15 µm)
					
					
▪ Four nuclei	▪ Small mature cysts ▪ Four nuclei ▪ Grape-like chromatoid bodies ▪ Immature cysts have 1-2 nuclei	▪ Single nucleus ▪ Large karyosome ▪ Large glycogen vacuole	▪ Pleomorphic cytoplasmic inclusions ▪ Cysts are usually uninucleate	▪ Eight nuclei ▪ Chromatoid bodies with splintered ends ▪ Immature cysts can have 1- 4 nuclei and glycogen mass	▪ Four nuclei ▪ Chromatoid bodies with rounded ends ▪ Immature cysts can have 1 - 2 nuclei and glycogen mass

Scale 20 µm

***Dientamoeba fragilis* (Trophozoite):** Appears often in stained smears to have two nuclei (about 60-80% of the time). The nuclei lack peripheral chromatin and have fragmented karyosomes (3 to 5 granules).

Epidemiology

- ***E. histolytica*** occurs worldwide, mostly in developing countries where sanitation and hygiene are poor.
- Infections are transmitted via the fecal–oral route.
- **Cysts** are usually ingested through contaminated water, vegetables, and food.
- Flies have also been linked to transmission in areas of fecal pollution.
- Most infections are asymptomatic, with the asymptomatic cyst passers being a source of contamination for outbreaks.

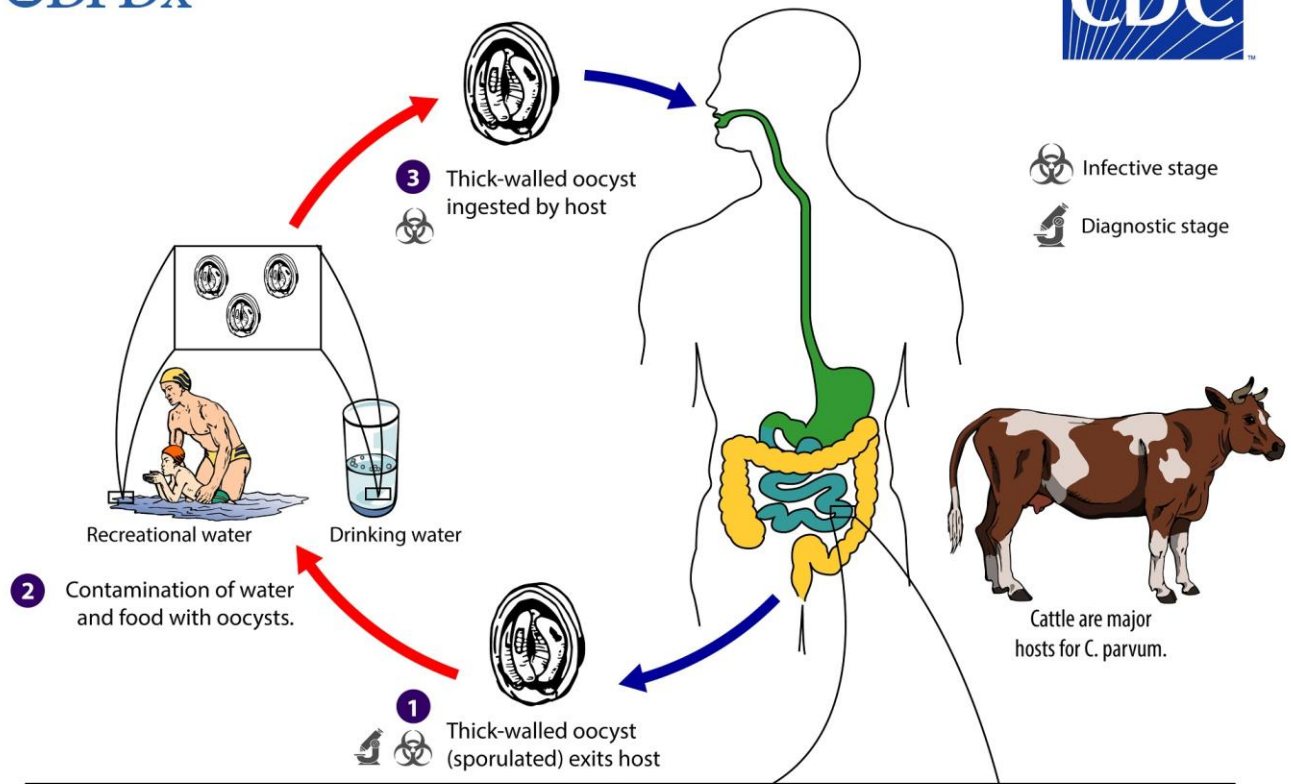
Cryptosporidium

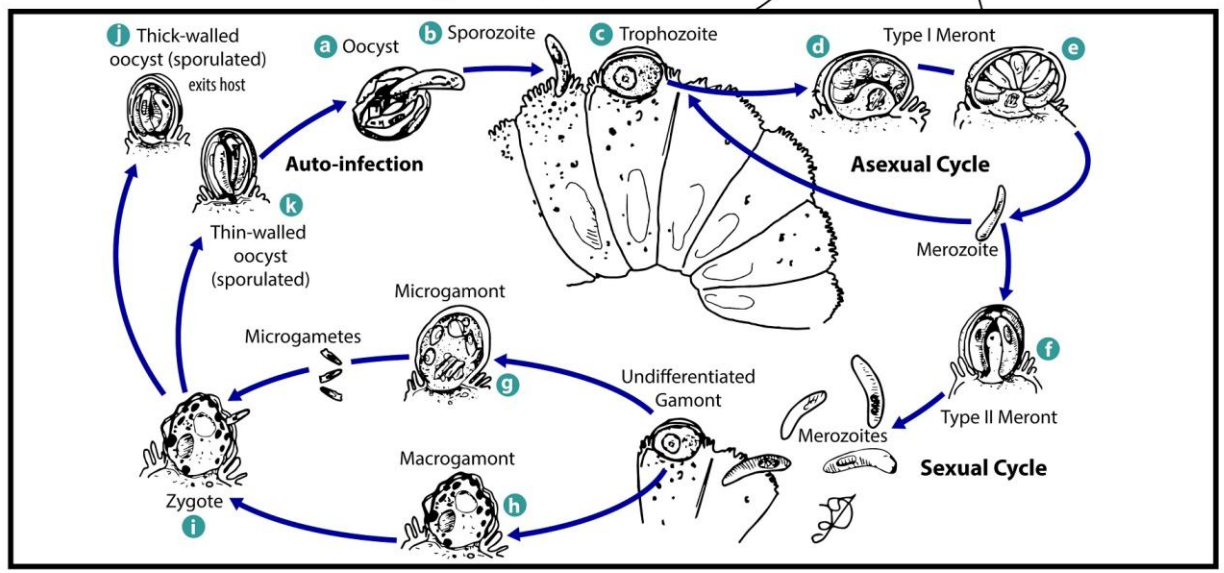
- ***Cryptosporidium*** species, cause infection in immunocompromised resulting in severe, intractable diarrhea.
- ***Cryptosporidium parvum*** (formerly known as C. parvum genotype II) and ***C. hominis*** (formerly known as C. parvum genotype I) are the leading causes of human cryptosporidiosis.
- Oocysts measuring **4–5 µm** are passed in feces in enormous numbers and are **immediately infectious**.
- When oocysts in contaminated foods and water are ingested, sporozoites excyst and invade intestinal cells.
- The parasites multiply **asexually** within the intestinal cells, are released to infect other intestinal cells; and **sexually**, forming male microgamonts and female macrogamonts that fuse and develop into oocysts.

DPDx

Cryptosporidium spp.

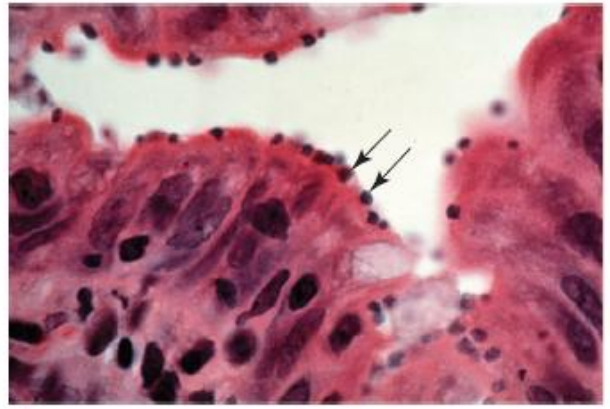
CDC



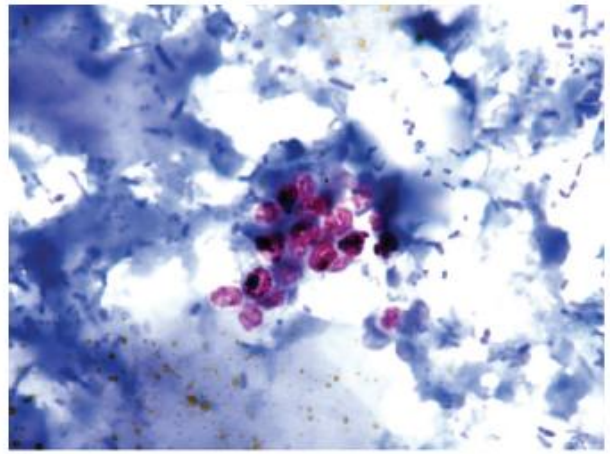


Site, Disease, and Diagnosis

- ***Cryptosporidium*** inhabits the brush border of mucosal epithelial cells esp villi of the lower small bowel.
- The prominent clinical feature is **watery diarrhea.**
- Disease is mild and self-limited **1–2 weeks** in normal persons; may be severe and prolonged in immunocompromised or extremes of age.
- The small intestine is the most commonly infected site, other digestive tract organs and the lungs could be involved.
- Diagnosis depends **on detection of oocysts in fresh stool samples.**
- Stool concentration techniques using **a modified acid-fast stain** are usually necessary.



A



B

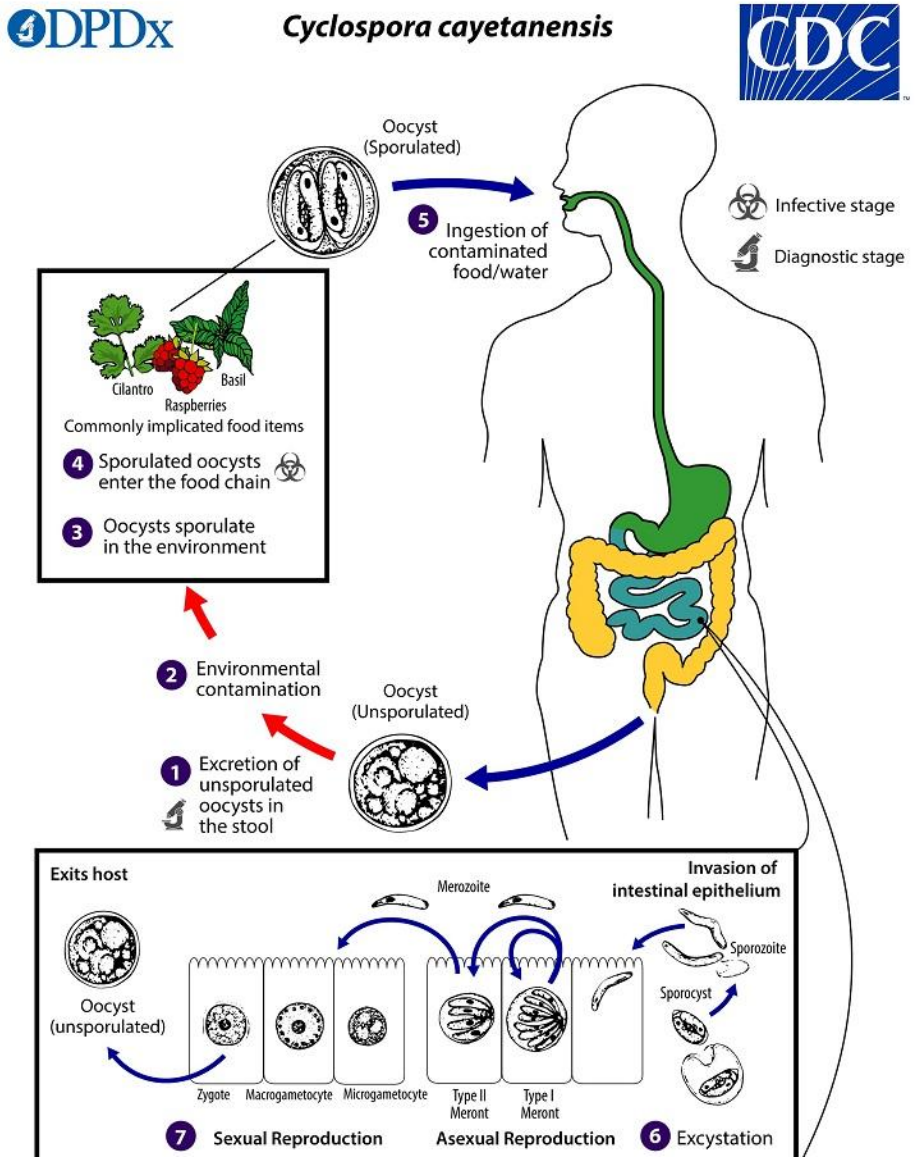
FIGURE 46-3 *Cryptosporidium.* **A:** Histologic section of intestine with organisms (arrows) at the apical portion of the epithelial cells. (Courtesy of Pathology, UCSF.) **B:** Oocysts (4–5 µm) stain pink in stool samples stained with a modified acid-fast stain. (Used with permission from Sullivan J: *A Color Atlas of Parasitology*, 8th ed. 2009.)

Epidemiology and Risk Groups

- The incubation period for cryptosporidiosis is from **1 to 12 days**.
- The disease is acquired from infected animal or human feces or from fecally contaminated food or water.
- For those at high risk, avoidance of animal feces and careful attention to sanitation are required.
- The organisms are widespread and probably infect asymptomatically a significant proportion of the human population.
- As few as **30 organisms** can initiate an infection.

Cyclospora

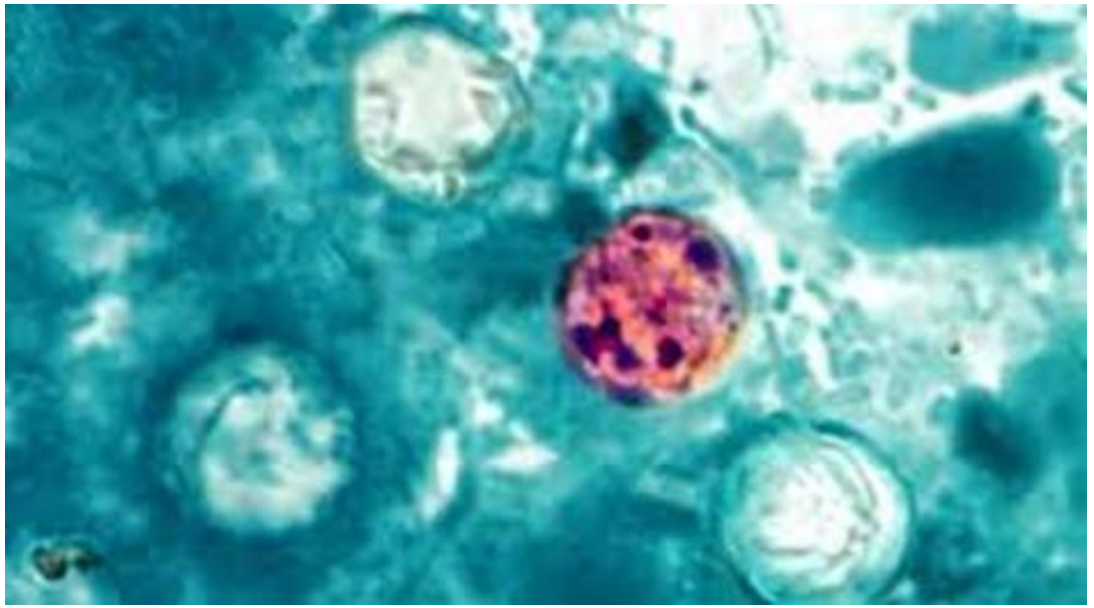
- The life cycle of **Cyclospora** is similar to that of **Cryptosporidium** and appears to involve only a single host.
- Unlike Cryptosporidium oocysts, which are infectious in the feces, Cyclospora oocysts take days or weeks to become infectious.
- Because of this, direct person-to-person transmission through fecal exposure is unlikely to occur.
- Cyclosporiasis has been linked to waterborne and foodborne infections from various types of fresh produce, including **raspberries, mesclun, and basil**.



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

Clinical Disease, Diagnosis, and Treatment

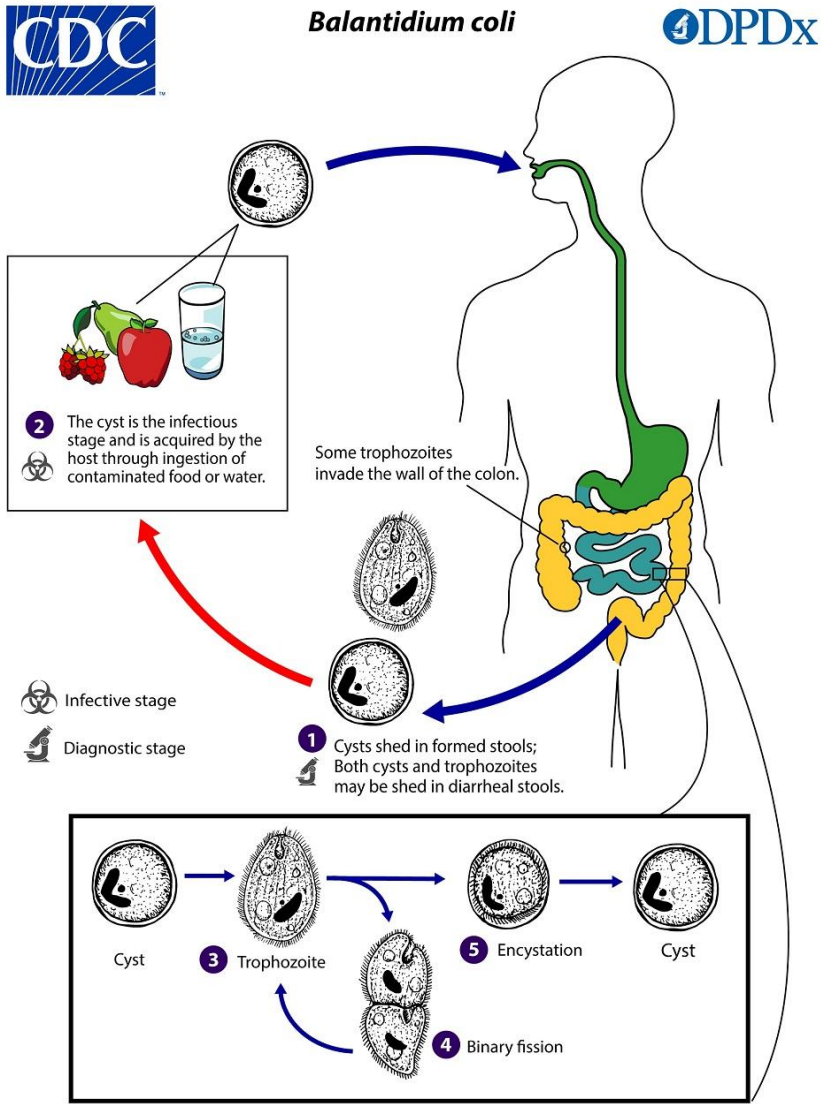
- Shortening of intestinal villi with edema and inflammatory cells leads to **diarrhea, anorexia, fatigue, and weight loss**.
- Symptoms may be prolonged, self-limited, and **remitting-relapsing** for weeks or months.
- Incubation period is about **1 week**.
- Diagnosis requires specific stool testing for **acid-fast oocysts, 8–10 µm**.
- Unlike infections with **Cryptosporidium**, Cyclospora infections are treatable with **trimethoprim–sulfamethoxazole**.



https://www.cdc.gov/cyclosporiasis/hcp/clinical-overview/index.html

Balantidium coli

- ***Balantidium coli*** is a **large ciliated protozoan** and the **only ciliate known to infect humans**.
- It is also sometimes called ***Neobalantidium coli*** or ***Balantioides coli***.
- **Swine are the primary reservoir hosts**; humans, rodents, and nonhuman primates may also be hosts.
- Infection occurs by ingestion of **cysts** in contaminated **food or water.**
- After ingestion, **excystation occurs in the small intestine**, and trophozoites colonize the **large intestine and appendix**.
- Trophozoites may invade the **colon wall**, causing **ulcerative pathology**.
- Most cases are **asymptomatic**, but disease may be acute or chronic with **abdominal symptoms, diarrhea, or dysentery**.
- Severe or fatal disease may occur in **immunocompromised persons**; rare extraintestinal disease includes **peritonitis and liver abscesses**.



Laboratory Diagnosis and Safety

- Diagnosis is based on detection of **trophozoites in stool samples** from symptomatic patients or in **tissue collected during endoscopy**.
- **Cysts** are less frequently encountered and are most likely to be recovered from **formed stool**.
- *Balantidium coli* is passed **intermittently** and is rapidly destroyed once outside the colon.
- Stool specimens should be collected **repeatedly** and immediately examined or preserved to enhance detection.
- Concentration by **sedimentation or flotation** can increase the probability of recovery.
- Standard stool-processing protocols apply; precautions such as **PPE** and **biosafety cabinet use** should be taken to avoid exposure to infectious cysts in unfixed stool specimens.

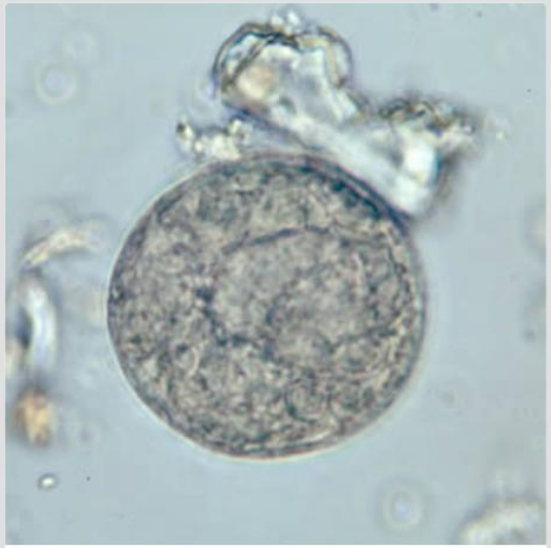


Figure A: *B. coli* cyst in a wet mount, unstained.

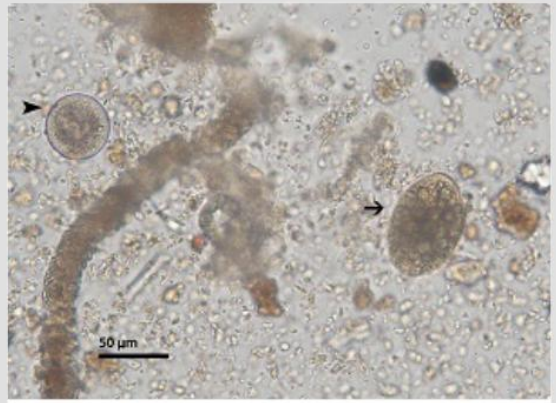


Figure B: *B. coli* cyst (dart) and trophozoite (arrow) in the same field, from a primate fecal sample.

References

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