

gastrointestinal Tract Diseases

Bacterial Diseases:

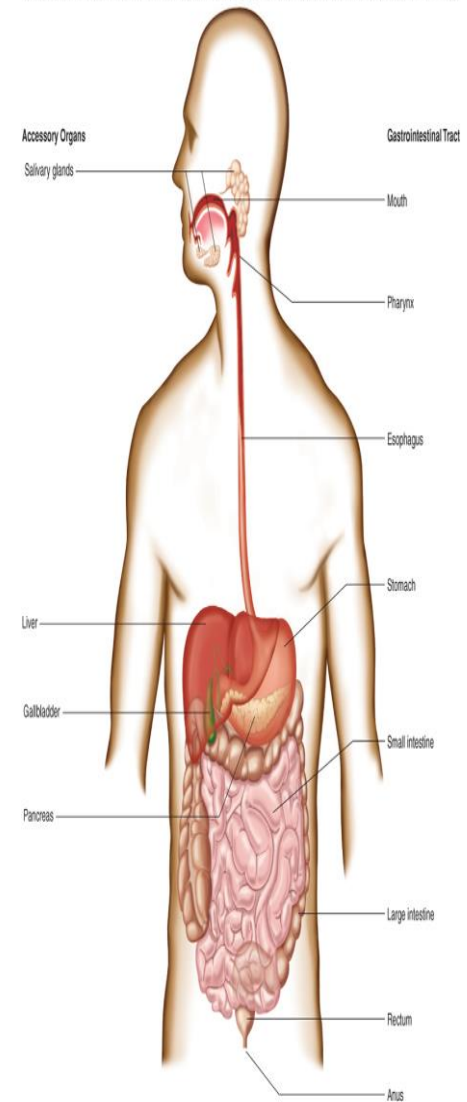
Food-borne bacterial **gastro-enteritis** may be of three types:

- (i) infectious type (e.g. salmonella or *Vibrio parahaemolyticus*), when bacteria infected with food multiply in the individual;
- (ii) toxin type (e.g. *Staphylococcus aureus*) when food is ingested that already contains a toxin;
- (iii) Intermediate type (e.g. *Clostridium perfringens*, which releases a toxin in the bowel).

The most important bacterial infections that gain entry through the gastro-intestinal tract are:

- the enteric fevers;
- the bacillary dysenteries;
- cholera;
- brucellosis;
- food-poisoning bacteria.

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

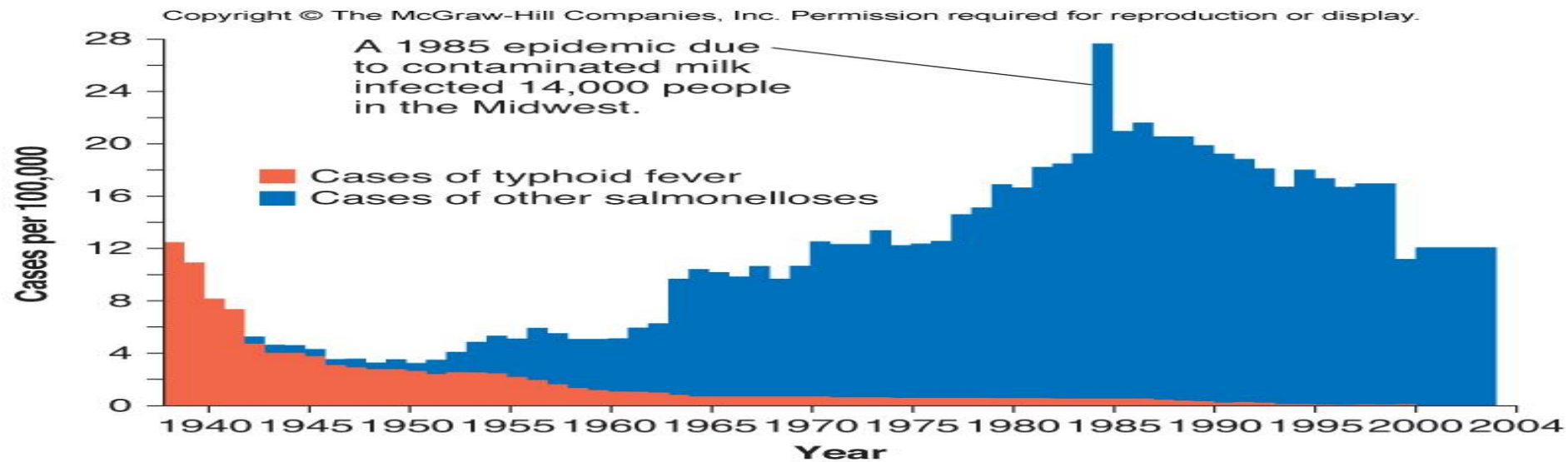


A. Enterica fever

1. Caused by *Salmonella typhi* (Typhoid fever), gram neg. rod, H₂S produ
2. It can survive in water for 7 days, in sewage for 14 days and in ice-cream for 1 month. In warm dry conditions most of the bacilli die in a few days. Boiling of water or milk destroys the organism.
3. Disease is caused by **invasive infection from small intestine into blood stream**. Bacteria multiply in phagocytes, resulting in septicemia. Causes both abdominal symptoms, fever, and other organ tissue damage. Result from both **exotoxin** as well as **endotoxin**.
4. Transmitted by contaminated water or food. Asymptomatic carriers (like the proverbial typhoid Mary) are a problem.
5. Epidemiology: the enteric fevers have a worldwide distribution although they are endemic in communities where the standards of sanitation and personal hygiene are low. Typhoid fever presents one of the classical examples of a water-borne infection. All ages and both sexes are susceptible.
6. Treated by broad spectrum antibiotic and prevented by proper sanitation, clean water supply. Vaccine is not all that effective.
7. Historically, this disease was a killer. It is still a problem whenever the water supply is threatened with contamination.

8. Reservoir: Humans are the only reservoir of infection. About 2–4% of typhoid patients become chronic carriers of the infection. The majority are faecal carriers. Urinary carriers also occur and seem more common in association with some abnormality of the urinary tract and in patients with *Schistosoma haematobium* infection.

9. Laboratory diagnosis: A leucopenia with a relative lymphocytosis is often seen. *S. typhi* is isolated from **blood** or 'clot' culture in the **first week** of disease, from **faeces** in the **second** and **following weeks** and from **urine** in the **3rd** and **4th weeks**. It can also be found in bile by duodenal aspirate culture and marrow cultures. Aprobe technique as well as the polymerase chain reaction (PCR) have been used. After about the **10th day** the **Widal test (O and H agglutinations)** becomes positive and rises progressively, a rising titer rather than absolute values is necessary for diagnosis.



B. *Salmonella* species (other than *S. typhi*) infection:

1. Gram neg rod, H₂S producer, noncoliform. Identified by biochemical.. characteristics plus serotyping.
2. Cause gastroenteritis - often called “food poisoning” but is actually an infection. The small intestine is usually the target for *Salmonella* infections. These infections need a large number of organisms to cause disease (large infectious dose – thousands of cells). Also have variety of exotoxins, depending on the species and endotoxin. Cause abdominal pain, diarrhea, nausea, vomiting, fever.
3. Transmission: Fecal/oral: improper sanitation, contaminated food.
4. Treatment: Usually not treated with antibiotics. These organisms are examples of selection of drug resistant bacteria from non-medical use.
4. Prevented by proper sanitation, food handling.
5. Thanksgiving and Christmas time outbreaks; improper handling of turkey (thawing, improper cooking temperatures, stuffing the bird – 165 F , 15 seconds, use a meat thermometer)

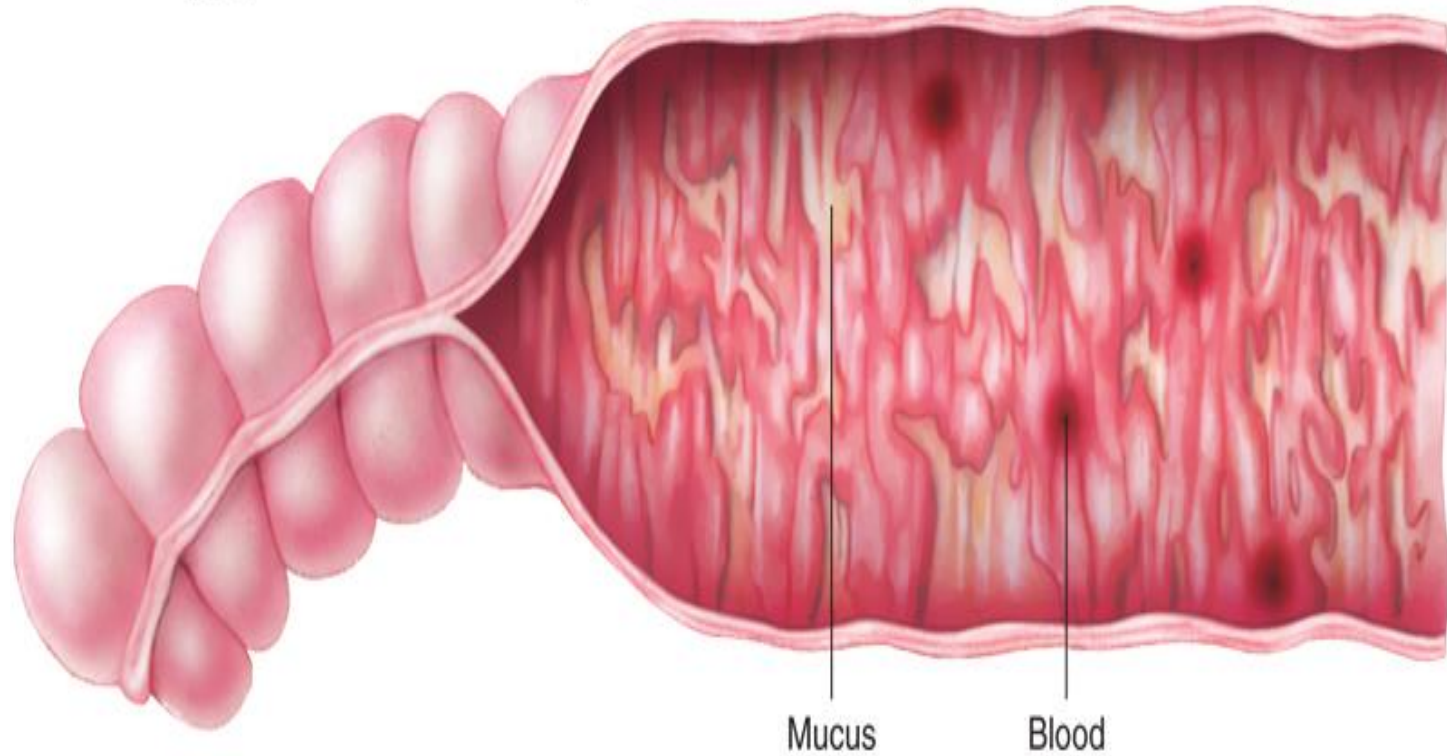
C. *Shigella* species infections:

1. Caused by: Gram negative noncoliform rod (lactose negative) fermentative bacteria, no H₂S or urease, nonmotile, closely related to *E. coli* (DNA and RNA)
2. Type of infection: Causes **bacillary dysentery**; abdominal cramps, watery and bloody stool. Diarrhea and vomiting. Affects the **large intestine**. Infects the cells lining the colon. Releases exotoxin, **Shiga toxin**, causing fever, inflammation, lesions that cause bleeding and heavy mucus secretions.
Remember: this is a Gram negative bacterial infection; therefore endotoxin is also a factor causing disease.
3. Transmission: Oral/fecal. Spread quickly in crowded conditions in day care or schools. Can be spread in contaminated food or water. 4 F's (Food, Fomites, Flies, Fingers)
4. Special characteristics: **Very small infectious dose required**. Treatment/prevention: Treat with broad spectrum antibiotic and rehydration.
5. Prevention: by proper sanitation and good hygiene. No effective vaccine.

Note: All diseases causing diarrhea will be treated with rehydration therapy if diarrhea/dysentery has been severe enough to result in significant dehydration.

Shigella infection

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



D. *Vibrio cholera*

1. Caused by **Gram negative** curved rod, oxidase positive. Many vibrios **need high salt concentration for growth**. However, *V.cholerae* can grow in fresh or salt water. They can survive in the salt water bays and marshes and thus can be acquired by improper cooking of shellfish—seafood)
2. Causes disease by release of **enterotoxin** (this refers to an **exotoxin** that is released by bacteria and affects the enteric system). The toxin, **cholera toxin**, disrupts the function of the small intestine by damaging the epithelial layers. This results in an imbalance in the electrolytes. This results in loss of fluid. In fact, stool is so watery it is termed “rice water” stool - Leads to dehydration and shock.
3. **Gastric acidity** is a major factor in host **resistance**, the disease being more common in persons with hypochlorhydria. Because gastric acidity declines in old age, the elderly are more seriously ill than younger persons.
4. Transmitted by contaminated water, foods usually contaminated by the water.
Reservoir in humans, shellfish, fish.
5. Treatment: Electrolyte and fluid replacement plus antibiotics such as tetracycline.
Oral rehydration therapy is given as much as possible.
6. Prevention: Vaccine is really inadequate. Proper hygiene is the best prevention.
Proper sanitation, clean water supply plus education for proper cooking, treatment of contaminated water.

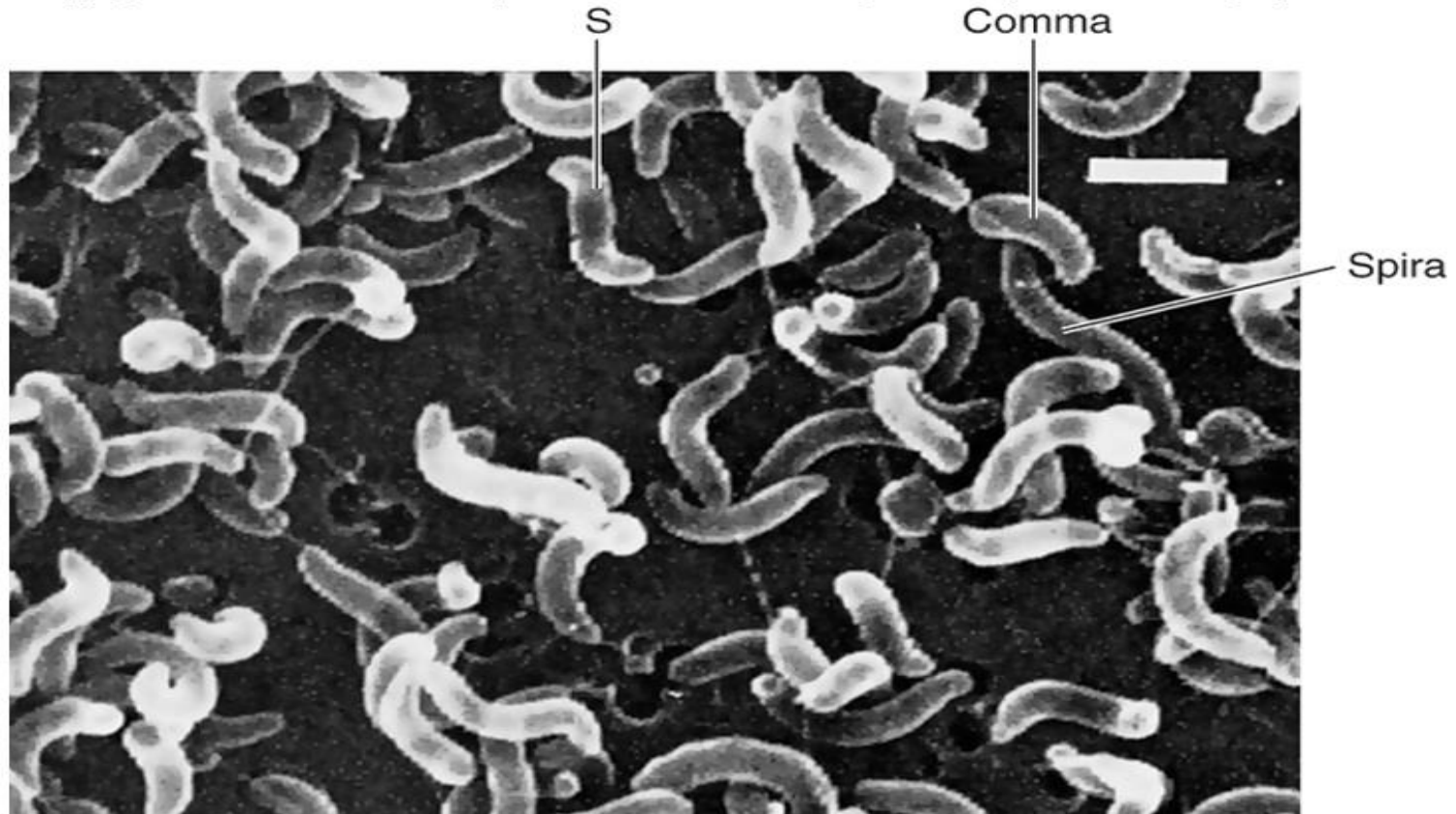
- **Cholera control programme:**

Within a national Control of Diarrhoeal Diseases programme the following activities are considered important for cholera control:

- the formation of a national epidemic control committee;
 - collection of stool specimens or rectal swabs from suspected cases;
 - provision of local, regional, and reference laboratory services for the rapid identification of *V. cholera*.
 - training in clinical management of acute diarrhoea;
 - continuing surveillance activities and maintenance of a diarrhoea case's record;
 - early notification of changes in the pattern of diarrhoea;
 - enforcement of basic principles of sanitation;
 - continuing health education;
 - establishment of mobile control teams in certain special circumstances;
 - management logistics for supply and distribution requirements.
- Cholera will ultimately be brought under control in the developing countries only when water supplies, sanitation and hygienic practices attain such a level that faeco-oral transmission of *V. cholerae* 01 becomes an improbable event.

Vibrio cholera

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



© R.R. Colwell and D.M. Rollins, "Viable but Nonculturable Stage of *Campylobacter jejuni* and Its Role in Survival in the Natural Aquatic Environment," *Applied and Environmental Microbiology*, 52(3):531–538, 1986. Reprinted with permission of American Society for Microbiology

E. Infection caused by *Escherichia coli*:

1. Caused by: Gram negative coliform; most strains are motile. Common as normal flora, but some strains cause disease ([toxigenic strains](#)).
2. Five groups of *E. coli* are known to cause diarrhoea:
 - (i) enteropathogenic (EPEC);
 - (ii) Enterotoxigenic (ETEC);
 - (iii) verocytotoxin-producing (VTEC);
 - (iv) enteroaggregative (EAaggEC);
 - (v) diffusely adherent *E. coli* (DAEC).
3. Types of infection: Can vary, depending on the presence and type of exotoxins. Some strains cause mild diarrhea and nausea (traveler's disease) to more serious diarrhea. **Shiga-like toxins** can result in hemorrhagic and invasive types of disease. Can cause HUS (hemolytic uremic syndrome) and *E. coli* is the leading cause of urinary tract infections. Remember that this is also Gram negative, hence endotoxin also produced.
4. Treatment: rehydration for less severe disease. Controversial antibiotic treatment in other cases.
5. Transmission and prevention same as above.

F. Additional bacterial infections:

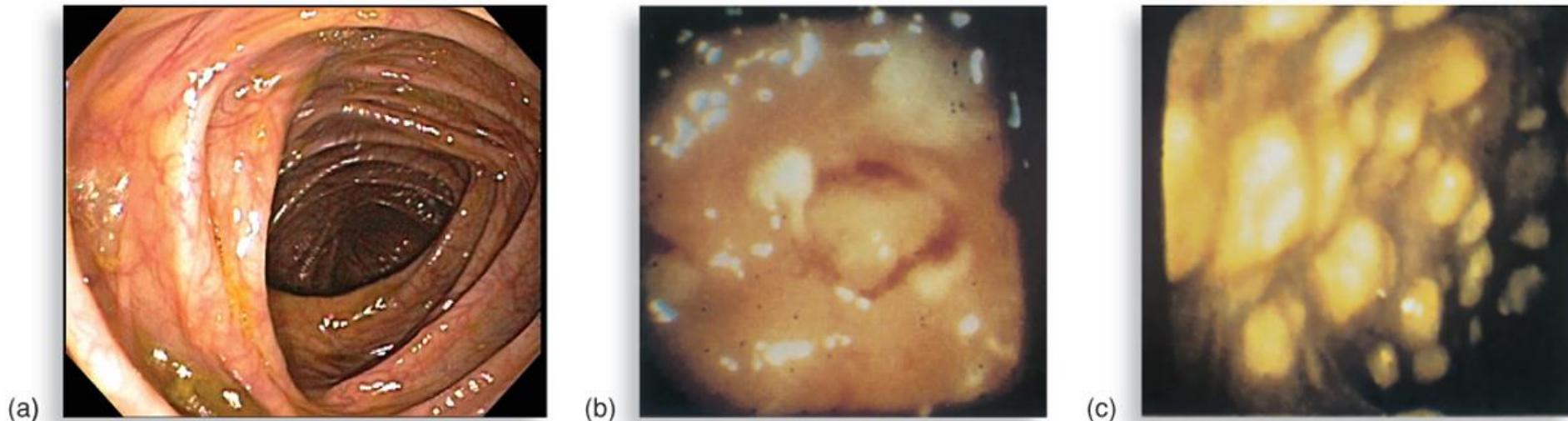
- *Streptococcus mutans*: Major contributor to dental plaque, resulting in gum disease as well as dental caries. Organism has heavy glycocalyx – can call this capsule or slime layer
- *Helicobacter pylori*: A curved rod which has special requirements for reduced oxygen. Also can tolerate the acid conditions of the stomach, resulting in gastritis and is cause of peptic ulcer (ulcer of the stomach.)
- *Campylobacter*: Two species of *Campylobacter*, *C. jejuni* and *C. coli*, are the causative agents of *Campylobacter* enteritis. Abdominal pain and diarrhoea are the common presenting symptoms.

Poor-quality drinking water, poor sanitation and intimate contact with animals are responsible for the hyperendemicity of this infection in developing countries. *C. jejuni* and *C. coli* are widely distributed in the intestines of a wide variety of birds and animals – it is a zoonotic infection. Indirect transmission occurs through raw milk, raw meats (especially poultry) and contaminated water. Direct transmission occurs among occupational groups such as farmers, veterinarians and butchers, and in the home through contact with infected pets. Person to person infection is common.

- ***Brucella species***: Human disease is attributed to *Brucella abortus*, *Br. suis* and *Br. melitensis* from cattle, swine and goat exposure respectively. Brucella are small, nonmotile, non-sporing, Gram-negative coccobacilli. Apart from their different CO requirements, the members of this group resemble each other closely in their cultural characteristics.
- ***Clostridium difficile***: an anaerobic rod. Normal flora but can be opportunist. Causes antibiotic-associated enterocolitis: affecting large intestine. Results from depletion of normal flora and selection for resistant *C. difficile*. Causes something called pseudomembranous colitis. Toxins produce pseudomembranes made up of fibrin and cells.

Antibiotic associated colitis, *C. difficile*, note (c), pseudomembranes

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



Food poisoning:

Some of the diseases we call food poisoning are really infections. Food poisoning really refers to the **pre-formed toxins ingested**. These have been secreted by the bacteria growing in the infected-contaminated food.

C. perfringens (gravies and thick stews not properly cooled and reheated in leftovers. common soil organism that may not be killed - improper cooking temperature, home canning. Preformed toxin is potent neurotoxin - causes disease of paralysis: neurological symptoms. (just a taste of contaminated food can be fatal)

- *B. cereus*, (rice dishes left too long in the danger zone)
- **Staph** like such foods as those with mayonnaise or cream pies, etc. The toxin usually causes gastroenteritis (vomiting, diarrhea) within 4 to 8 hours or less. This is much quicker than symptoms caused by infection by Salmonella, the other most common cause of gastroenteritis, or *E. coli*. (since they are infections, 1 to 2 days for onset of symptoms)

Protozoan and Helminth Diseases

A. Protozoan Diseases

1. Amebiasis

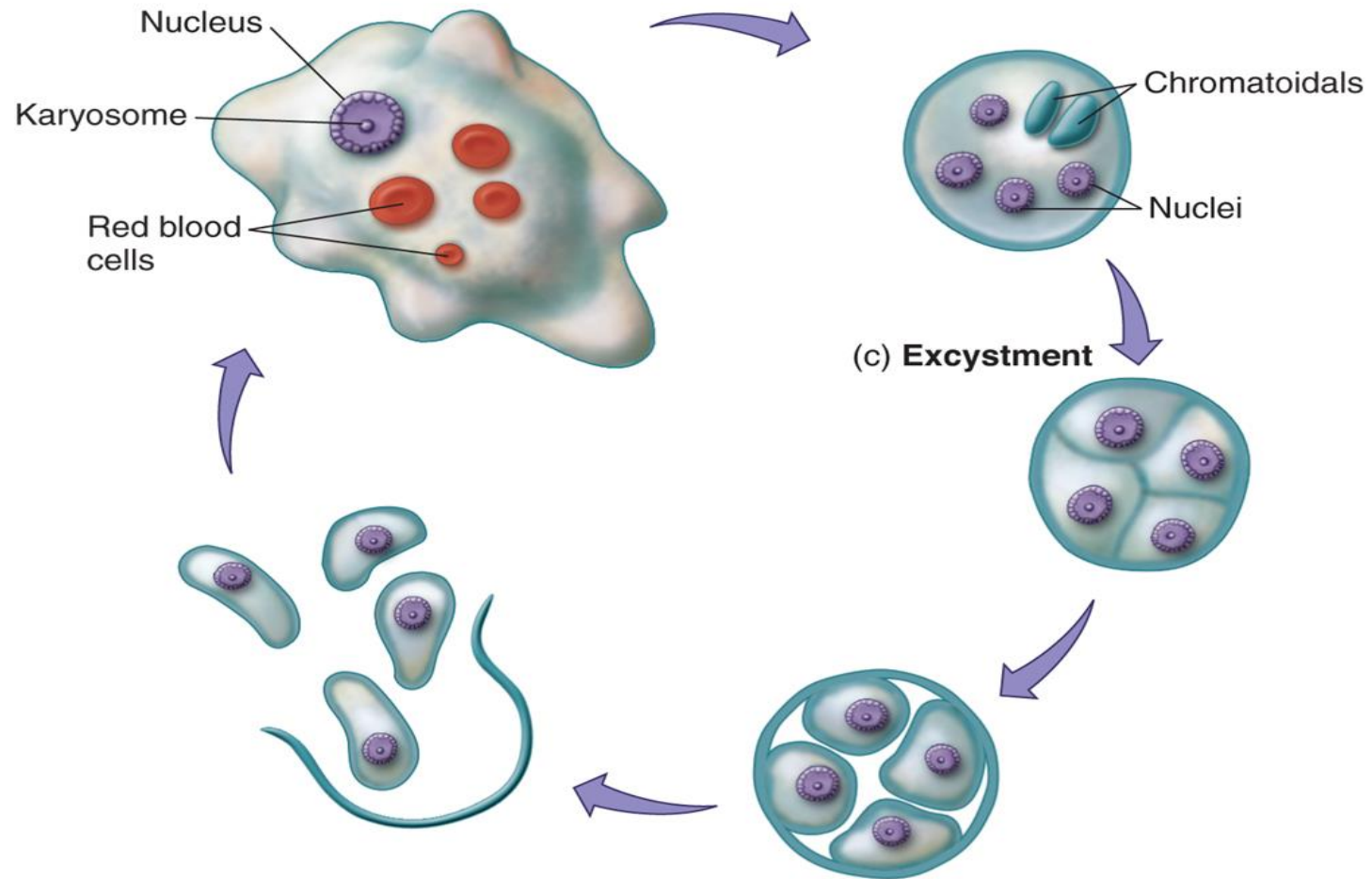
- a. Caused by *Entamoeba histolytica*, amoeba: Sarcodina, has two forms: trophozoite and cyst
- b. Transmitted by ingesting cysts from contaminated water or food
- c. Type of disease: Causes dysentery, abdominal pain, fever, and diarrhea. Trophozoites attach to walls of large intestine. In some cases can also invade other tissues, especially the liver and lungs. (Travels to these sites by way of peritoneum and diaphragm.)
- d. Diagnosed by presence of cysts in feces. Some serological tests also available.
- e. Treated with drugs such as iodoquinol and metronidazole.
- f. Prevented by proper sanitation, safe drinking water, adequate cooking of food.

Entamoeba histolytica life cycle

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

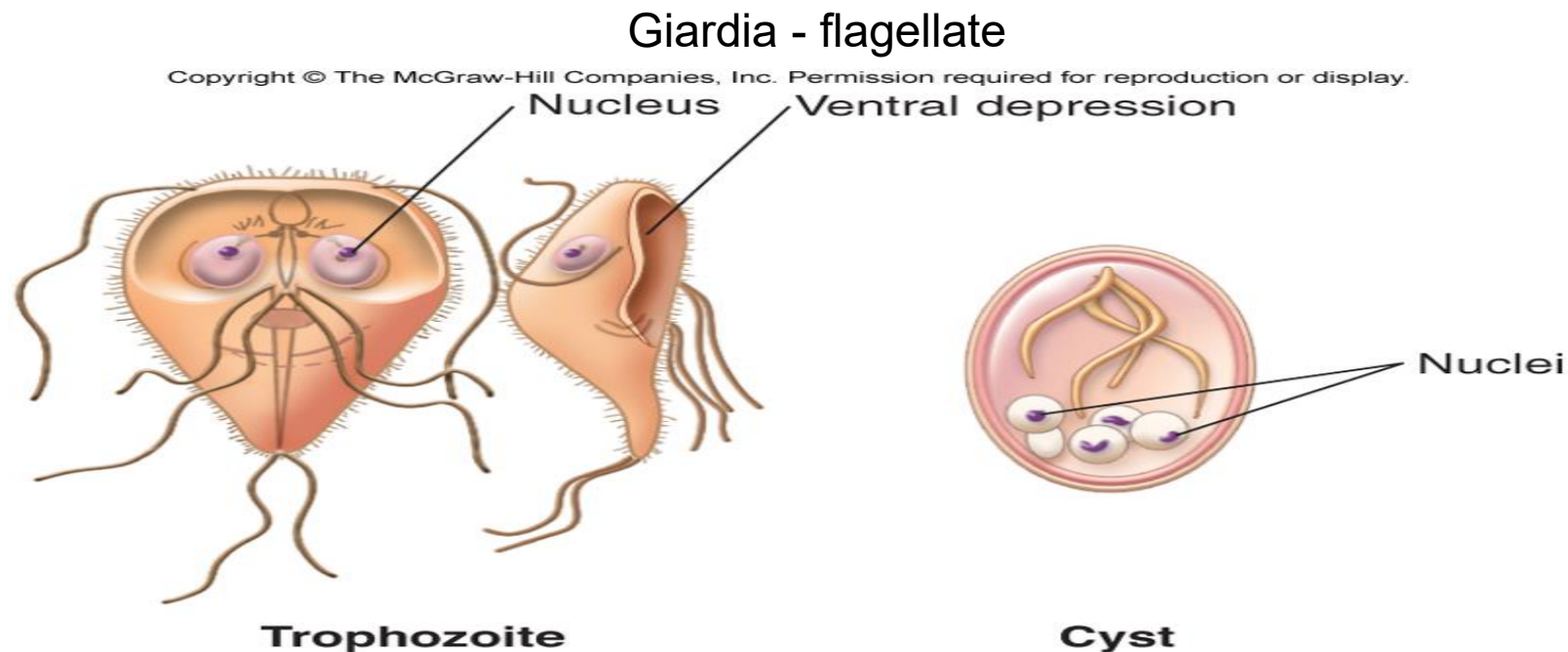
(a) **Trophozoite**

(b) **Mature Cyst**



2. Giardiasis:

- a. Caused by [Giardia lamblia](#), a [flagellated protozoan](#). (both amoebas and Giardia have [cyst and trophozoite](#) forms in life cycle)
- b. Infects the [small intestine](#). Causes diarrhea, abdominal pain, flatulence, and muscular weakness.
- c. Transmitted by oral/fecal route. By contaminated food or water, by fomites, close contact. Wide host range will contaminate streams and rivers. Sometimes called “hikers disease.” . cysts are ingested, excysted, trophozoites formed.
- d. Treated with metronidazole. Prevention: same



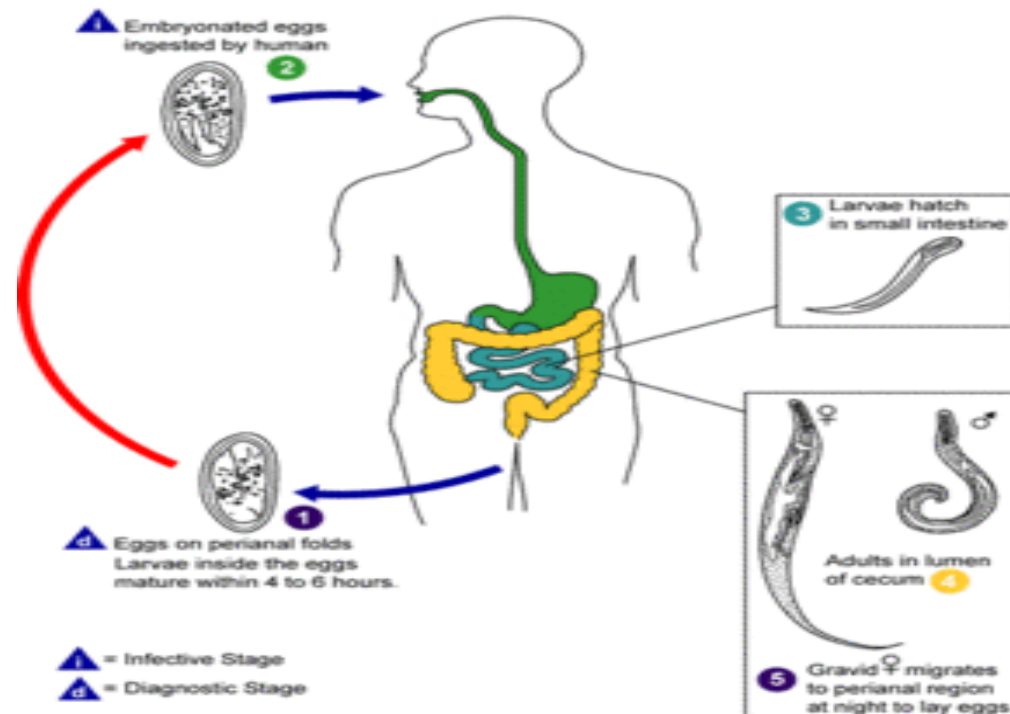
B. Helminthes:

Many important helminthes are transmitted through the gastro-intestinal tract and the infections they give rise to can be classified as in the following table:

Roundworms (Nematodes)	Tapeworms (Cestodes)	Flukes (Trematodes)
Ascariasis	Taeniasis	Paragonimiasis
Trichuriasis	Diphyllobothriasis	(lung)
Enterobiasis	Hydatid disease	Chlonorchiasis
Toxocariasis	Hymenolepsiasis	(liver)
Trichinosis		Opisthorchiasis
Dracontiasis (filarial worm)		(liver)
		Fascioliasis
		(liver)
		Fasciolopsiasis
		(intestine)

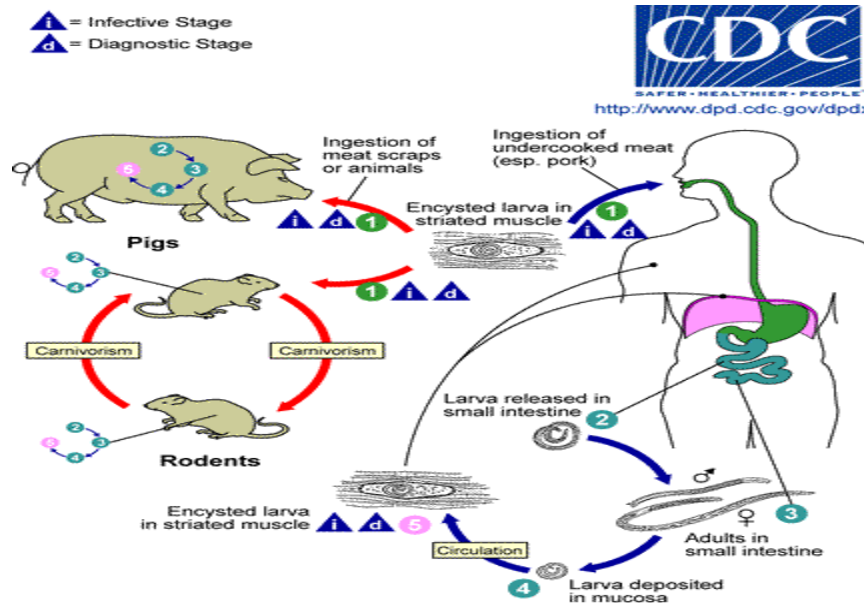
1. Pin worm:

- a. Caused by *Enterobius vermicularis*, a round worm. (Nematode)
- b. Common childhood infestation – “a family affair” Causes itching and irritation.
- c. Spread by eggs (ova). Female lays eggs outside the anus. Itching results in scratching: eggs deposited anywhere hands touch. Ova are ingested; develop into adult male and female worms in intestines.
- d. Treated with anti-helminthic drugs. Caused by close contact, poor hygiene.



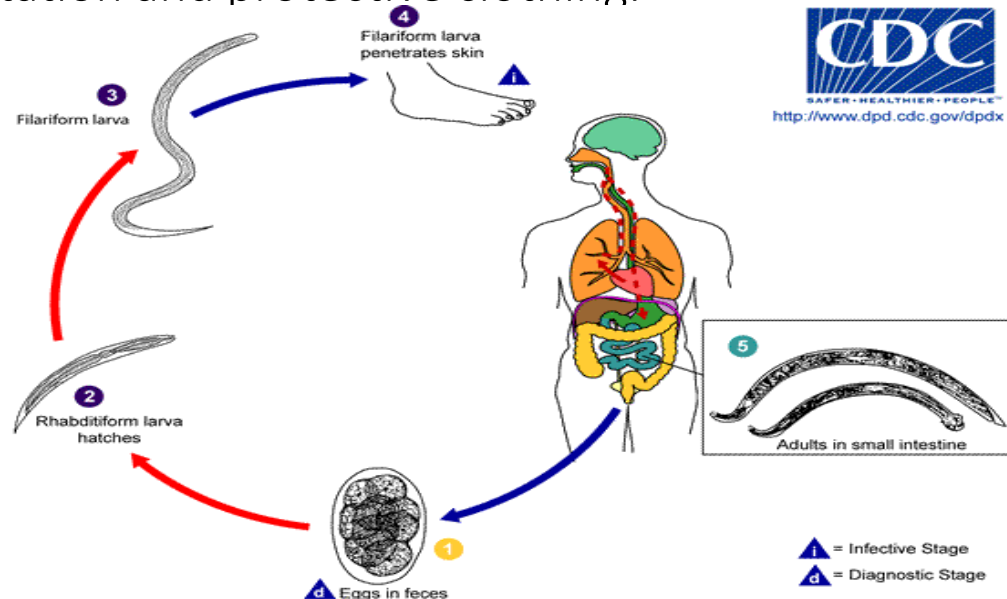
2. Trichinosis:

- a. Caused by *Trichinella spiralis*, a roundworm.
- b. **Transmission**: transmitted by eating meat infected with **encysted larva**.
Takes two hosts: Humans are usually infected by eating pork (or bear meat) that has encysted larval forms in muscle tissue. When cyst was eaten, it **develops into larvae and adults**.
- c. Type of infection: The adults produce live larvae that **migrate in blood to organs and become encapsulated**. Damage depends on the tissue affected.
- d. Prevented by eating non-infected meat, and by proper cooking of meat.



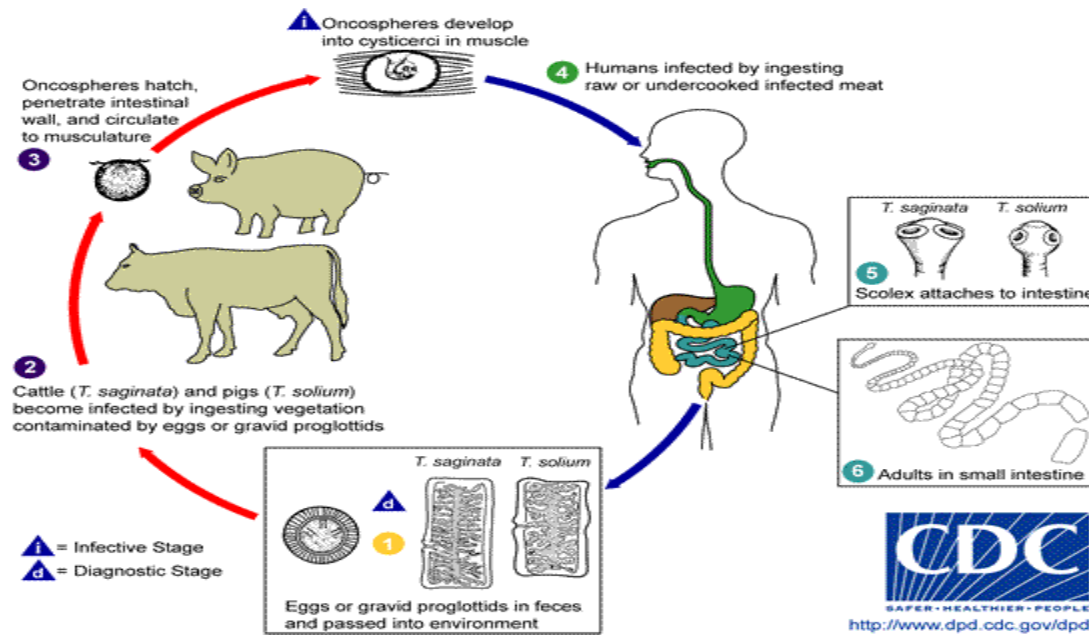
3. Hookworm

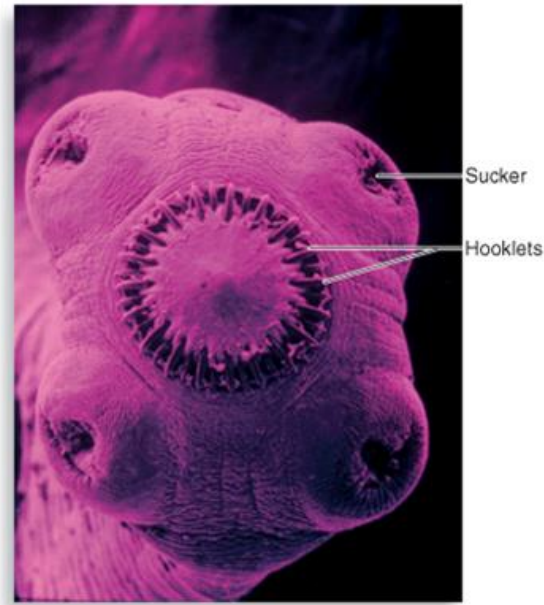
- a. *Necator americanus*: another round worm.
- b. Human is the host. Causes damage to the walls of the intestines, where adult worms hook on and feed on blood supply. Can cause anemia. Severe intestinal distress.
- c. Transmitted by live larvae in soil: Life cycle: Ova are transmitted through feces. Ova will develop into larvae in the damp warm soil. The larvae will burrow into skin of human (usually skin between toes, if barefoot), migrate through the circulatory system, eventually coming back to intestines.
- d. Can be prevented by proper sanitation and protective clothing.



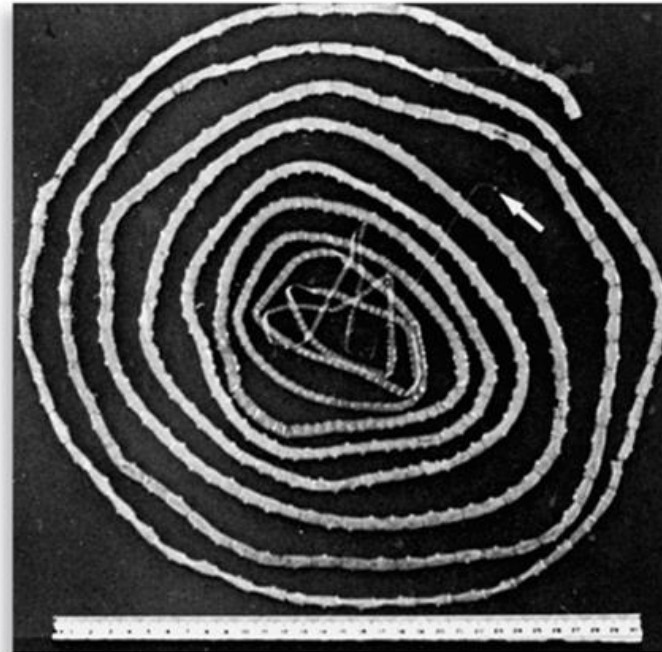
4. Tapeworm: Have both beef and pork tapeworms.

- a. Beef: *Taenia saginata*, Pork: *taenia solium*.
- b. Transmitted by eating encysted form (called *cysticercus*) in improperly cooked meat. Need two hosts: the beef or pigs eat *the cysts* deposited by from feces of humans. Cysts develop into larvae which encyst in muscle tissue. Humans eat infected meat: cysts develop into larvae and adults. Ova deposited in feces, thus a cycle.
- c. Cause disease by *draining nutrients*; can cause *intestinal blockage* if in large numbers. In case of *pork tapeworm*, humans can also be infected by ova: causes *cysticercus in human tissues*.





(a)



(b)