University of Zambia
School of Medicine

The Parasitic Flagellate

Giardia lamblia

The Parasitic Flagellates

- Intestinal and Urogenital system:
  - *Giardia* and *Trichomonas*

- Blood and Tissues:
  - *Trypanosoma* and *Leishmania*

Flagellates

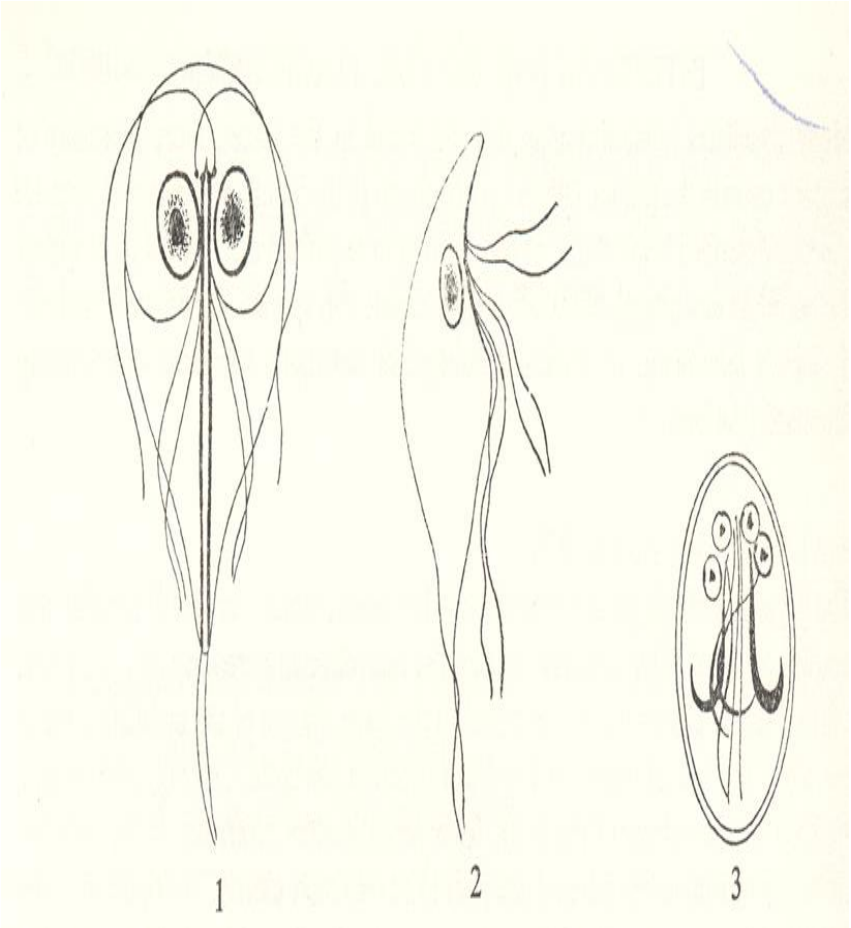
- Phylum: **Sarcomastigophora**
- Subphylum: **Mastigophora**
- Class: **Zoomastigophora** (mastix:whip)
- Suborder: **Diplomonadina**
- Genus: ***Giardia***, ***Trichomonas***, ***Chilomastix***, ***Enteromonas***

Giardia lamblia

- ***Giardia lamblia*** **(Syn. *Giardia intestinalis*, *Giardia duodenalis*)**
- Disease caused = **Giardiasis**
- Named after Prof. A. Giard & Prof. F. Lambyl in 1915
- **Habitat**: upper duodenum, adherent to microvilli

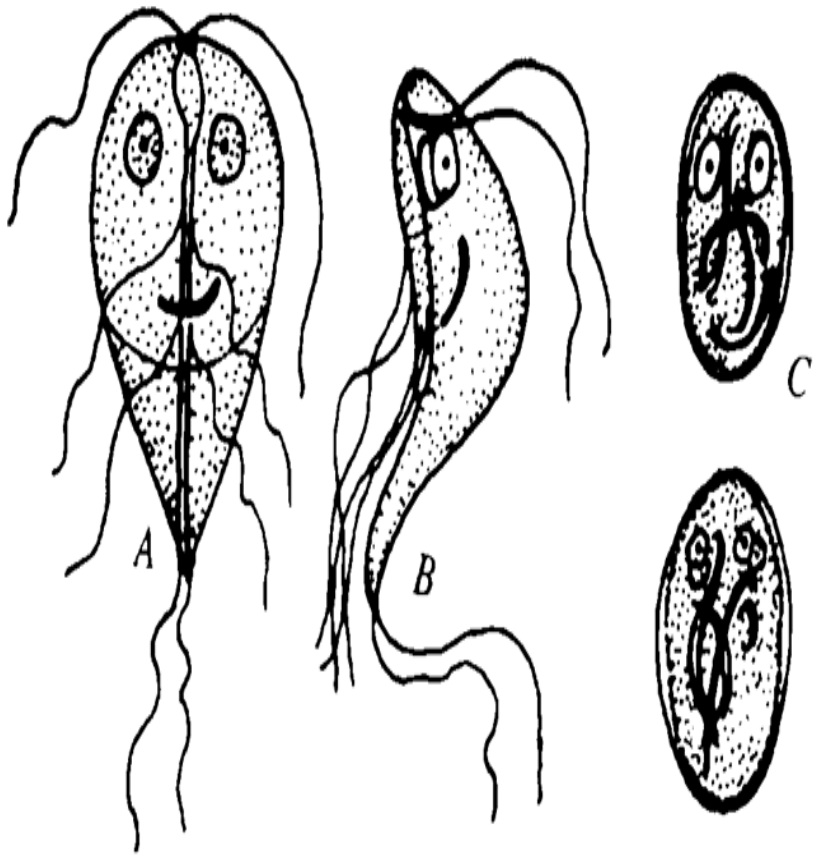
Morphology: trophozoites & cysts

- **Trophozoites**: contains 4 pairs of flagella, directed posteriorly that aid the parasite in moving, bilaterally symmetrical, pear shaped (pyriform), rounded anteriorly, tapering posteriorly
- Dorsal surface convex
- Ventral surface concave
- Sucking disc half anterior
- 9 – 21µm long x 5 – 15 µm broad x 1.5µm thick



Giardia lamblia

- **Trophozoite**: a. ventral view; b. profile view
- **Trophozoite**: has a convex dorsal surface and a flat ventral surface that contains the ventral disc, rigid cytoskeleton & composed of microtubules and microribbons
- **Cyst**: c. immature and mature with four nuclei

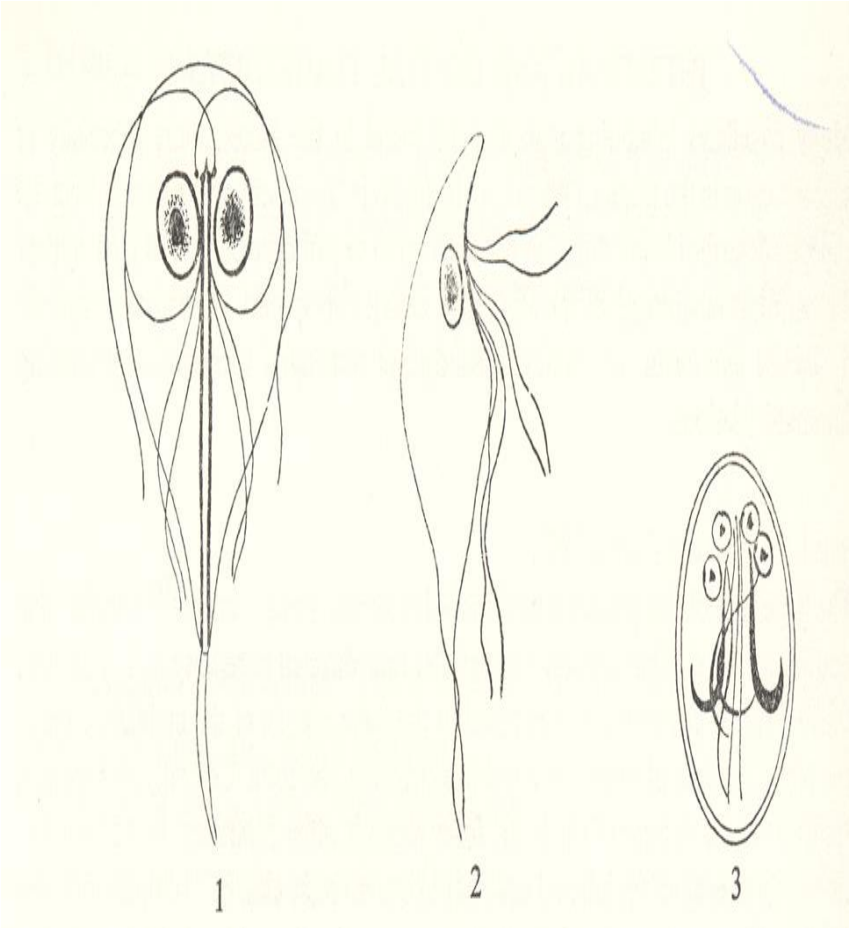


Giardia lamblia

1. Trophozoite – lying flat

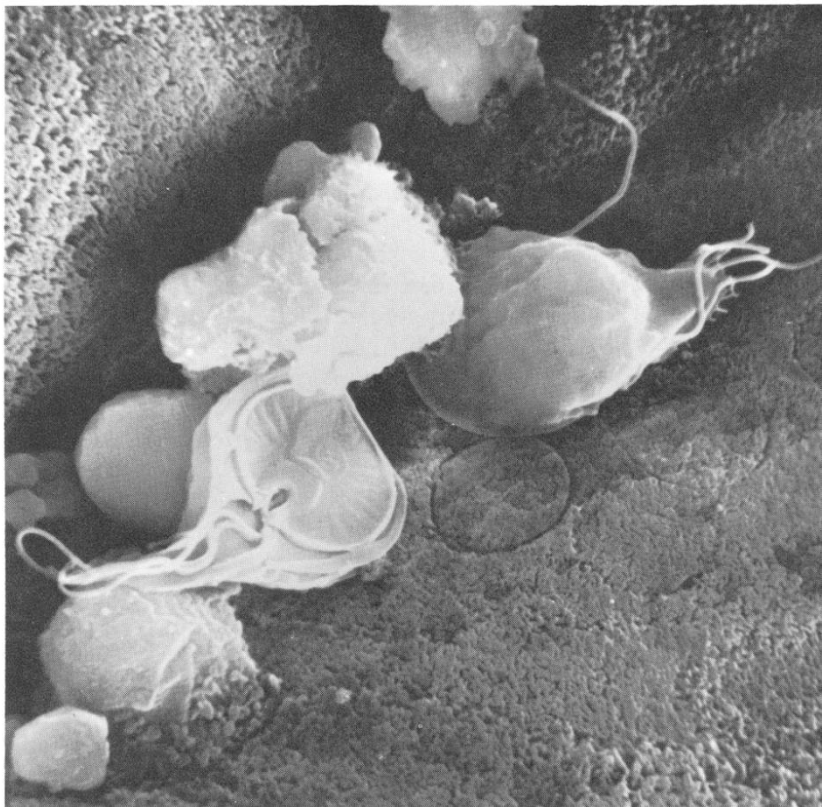
2. Trophozoite – side view

3. Cyst



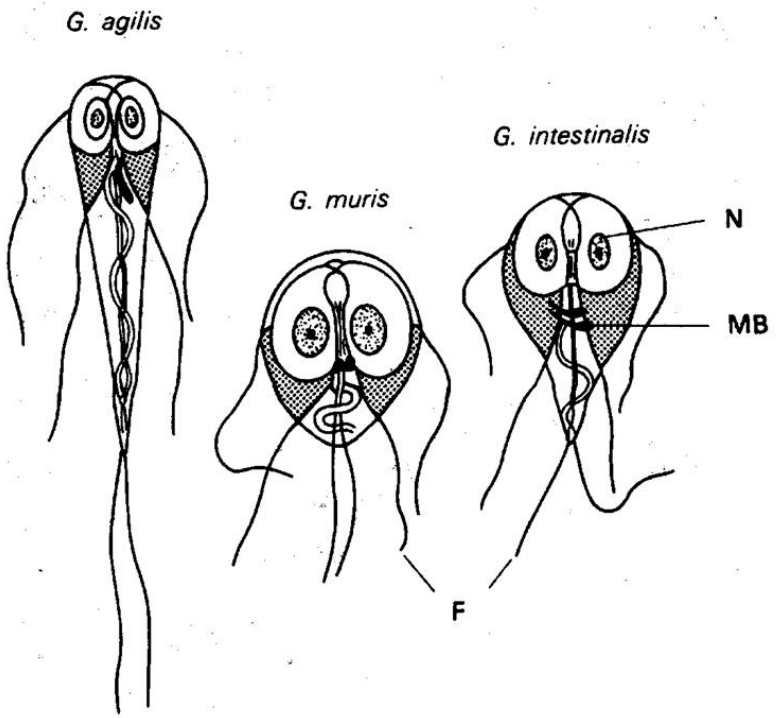
Giardia lamblia

- Scanning electron micrograph of *Giardia lamblia*, showing sucking disc and flagella; imprints of sucking disks are seen on surface of intestinal mucosa



Giardia species

- *G. agilis*, *G. muris* and *G. lamblia*
- N=nucleus
- MB=median body
- F=flagellum

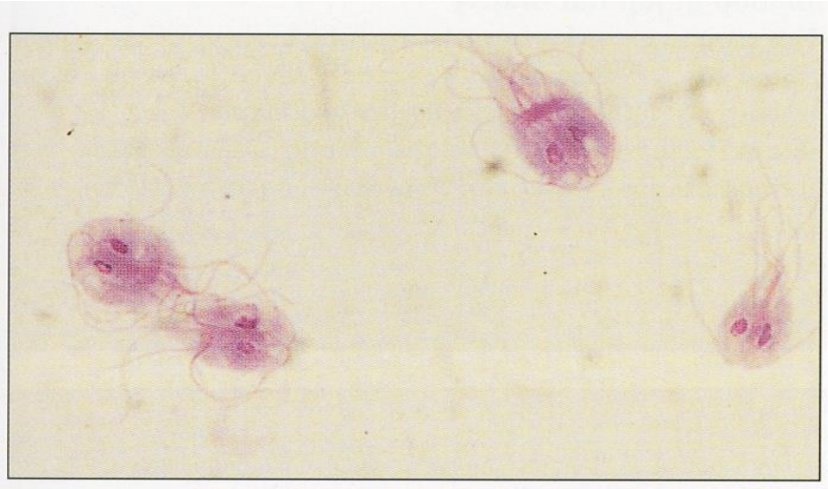


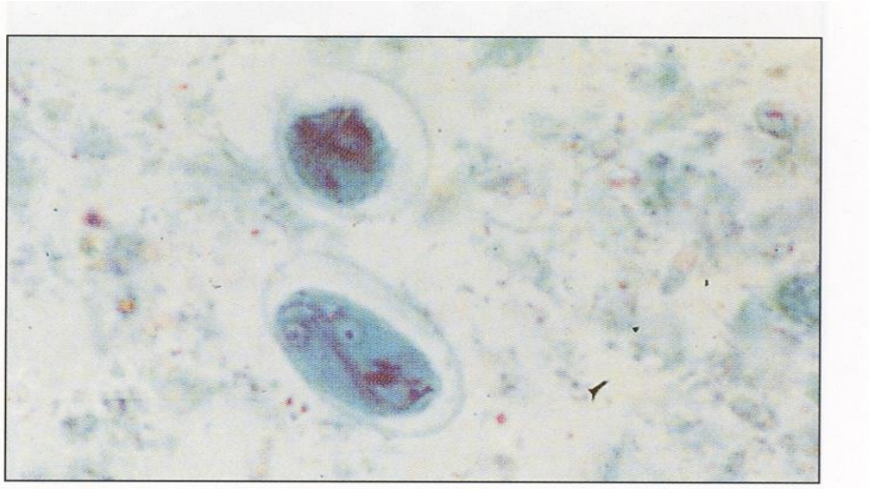
Cysts

- Thick smoothed cyst wall, ovoid in shape or elliptical
- 8 – 12µm long x 7 – 12µm wide
- 4 pairs curved bristles, 4 nuclei either clustered at one end or present in pairs at opposite ends
- Cytoplasm off the wall anteriorly
- Axostyle runs diagonally through the cyst
- Flagella shorten and are retracted within cyst
  - Provide internal support

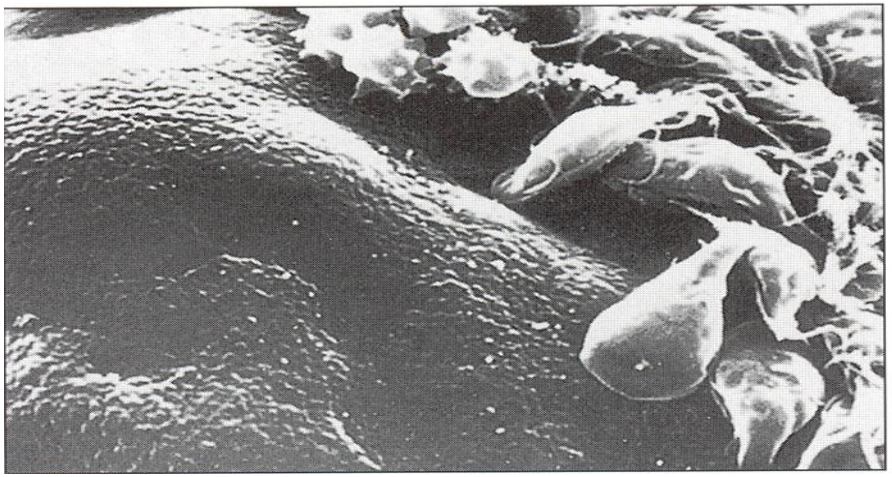
Giardia lamblia - cysts

Giardia lamblia trophozoites and cysts. Giardiasis is probably the commonest, globally distributed, water-borne protozoal infection. It has been estimated, for example, that two million new infections may be acquired in the USA each year from contaminated water. The flagellated trophozoites (left) attach by their suckers to the surface of the duodenal or jejunal mucosa. The ovoid cysts in faeces (right) have a very distinctive structure. They are able to survive standard chlorination procedures, and filtration is required to ensure their exclusion from the drinking water supply. (left Giemsa ; right trichrome)





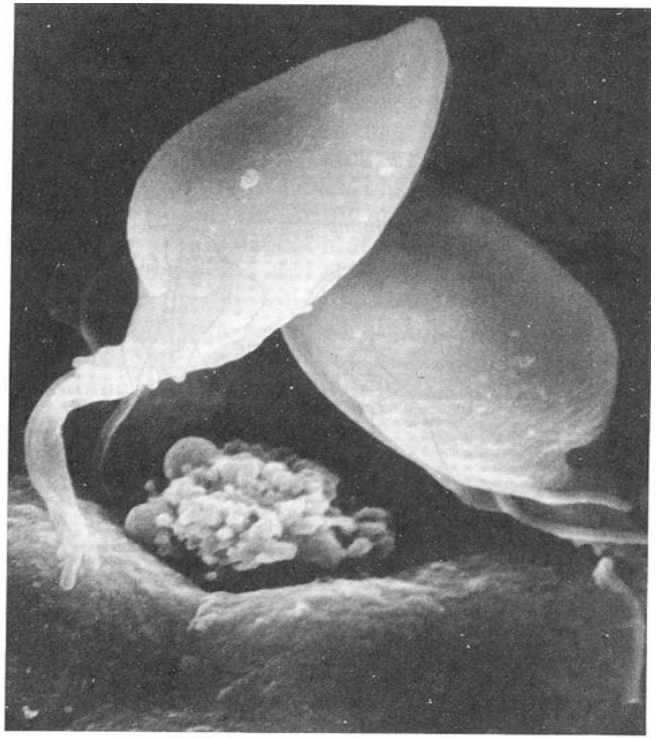
Giardia lamblia - trophozoites



Scanning electron micrograph of *G. lamblia* in jejunal biopsy The trophozoites are attached to the surface of the jejunal *Giardia* epithelium by sucker-like organelles, which leave pit marks when they detach. Their ability to produce at least 12 variable surface proteins assists the trophozoites to evade host antibodies. Infection may therefore become chronic.

Giardia lamblia - trophozoites

Scanning electron micrograph showing two *G. intestinalis* trophozoites.



Risk Factors

- Travel in developing world
- Changing diapers
- Eating food without cooking
- Eating fruits or vegetables without washing
- Owning a dog
- Other groups at increased risk for infection include:
  - children in day care institutions, homosexual men, individuals with immunoglobulin deficiency states (inherited or acquired)

Giardiasis

- Is a parasitic disease caused by *G. lamblia*
- Giardiasis is a major diarrhoeal disease found throughout the world
- Zoonosis: Giardiasis usually represents a zoonosis with cross-infectivity between animals and humans

Transmission

- Infective form – mature cyst passed in faeces of man
- Route of transmission
  - Faecal-oral
    - Ingestion of contaminated water-most important
    - Ingestion of contaminated food
  - Person to person-day care, nursing homes, mental asylums (poor hygiene)
  - Sexual-sexually active homosexual males

Life cycle

- *Giardia* has one of the simplest life cycles of all human parasites
- The life cycle is composed of 2 stages, trophozoite and cyst
- Acquire infection through ingestion of mature cysts
- Excystation occurs in stomach & duodenum within 30 minutes
- Two trophozoites hatch from one cyst

Life cycle

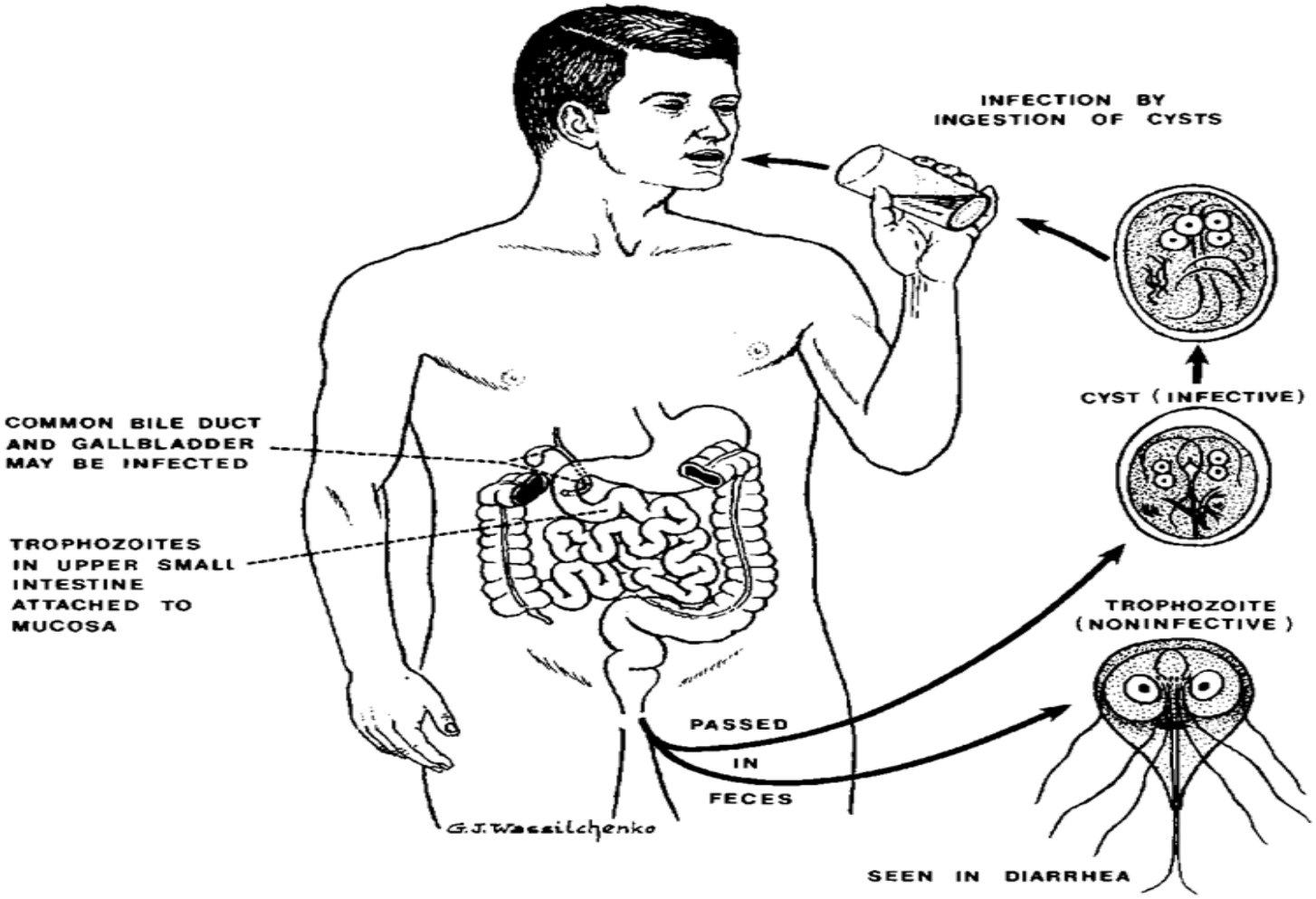
- Trophozoites multiply by binary fission & colonize in duodenum & upper jejunum
- Trophozoites adhere to enterocytes by ventral suckers
- Encystation occurs in transit down the colon
- Axonemes retract, cytoplasm condenses & thin tough hyaline wall is secreted

Life cycle

- Encysted trophozoites undergo nuclear division – mature quadrinucleate cyst
- Cysts passed in faeces into the environment
- No intermediate hosts are required

Life cycle of Giardia lamblia.

Multiplication by binary fission by trophic stage
Transmission: 5fs – direct and indirect



Giardiasis

- Incubation period: Averages 1 – 2 weeks
- Average duration of symptoms ranges from 3-10 weeks
- The infective dose: In humans about 10-25 cysts & are capable of causing clinical disease in 8 of 25 subjects
- Ingestion of more than 25 cysts results in 100% infection rate

Pathogenesis

1. Trophozoites do not invade tissue, feed on mucosal secretions

2. Trophozoites released, use their flagella to ‘swim’ to the microvilli covered surface of duodenum and jejunum where they attach to the enterocytes using their adhesive disc

3. Lectins present on the surface of *Giardia* binds to receptors present on surface of enterocytes causing duodenal irritation and inflammation of villi in duodenum & jejunum and damage epithelial brush boarder

Pathogenesis

4. Attachment process leads to damage of microvilli, which interfere with nutrition absorption by villi causing excess mucus secretion and dehydration

5. Rapid multiplication of trophozoites eventually creates a physical barriers between the enterocytes and intestinal lumen, further interfering with nutrition absorption.

Pathogenesis

6. This process leads to enterocytes damage, villi atrophy, crypt hyperplasia, intestinal hyperpermeability and brush boarder damage that causes a reduction in disaccharide enzyme secretion

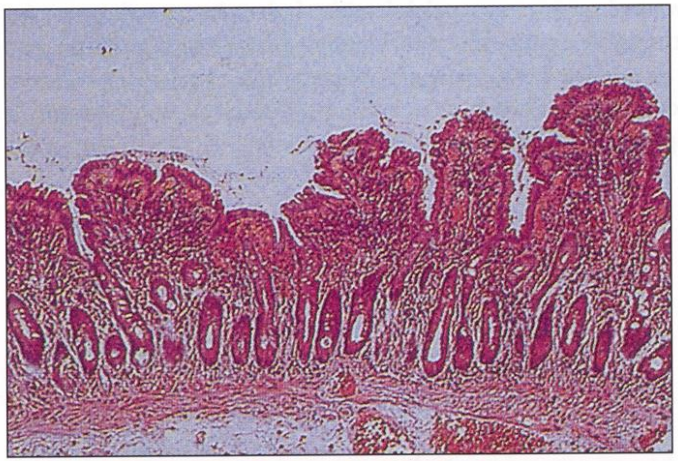
7. Lectins and other cytopathic substance secreted by parasite also causes indirect damage to intestinal epithelium

Pathogenesis

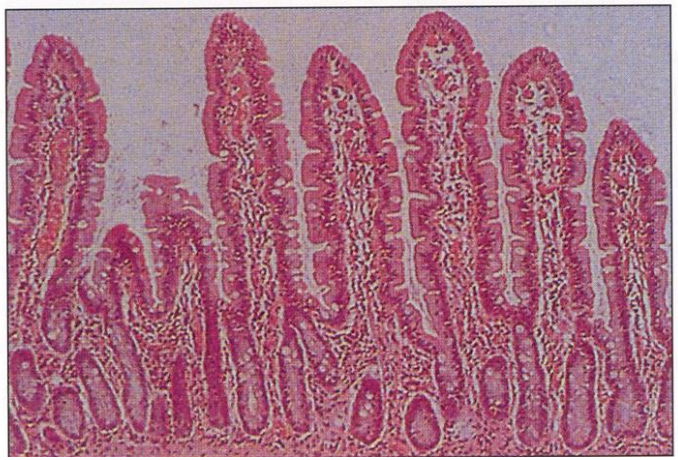
8. Giardiasis results in decreased jejunal electrolyte water and glucose absorption, and damage to intestinal epithelium leads to malabsorption of electrolyte and fluids, resulting in osmotic diarrhoea known as giardiasis

9. Occasionally, trophozoites can enter gall bladder, bile duct leading to jaundice

Pathogenesis



Jejunal epithelium severe infection with Giardia lamblia can result in partial villous atrophy of the duodenum or jejunum, with resulting flattening of the villi



Although the organism is commensal in many individuals, it is considered particularly pathogenic in children in the New World and is a common cause of diarrhoea and a malabsorption syndrome characterised by steatorrhoea in travellers

Symptoms

- Asymptomatic: largest group
- **Acute:** self-limiting infection, acute watery diarrhoea, dull epigastric pain, bloating, vomiting, nausea and flatulence
  - Stool is profuse & watery in earlier disease
  - Voluminous, foul smelling & greasy (Steatorrhoea) later
  - Loss of appetite, malaise, nausea, vomiting

Symptoms

Chronic: chronic diarrhoea with malabsorption of fat (steatorrhoea) i.e. stool contains large amounts of mucus and fat = tropical sprue or the yellow syndrome & foul smelling)

- Malabsorption of vitamin A, protein and D-xylose leading to
  - Chronic illness with weight loss
  - Failure to thrive in children
  - Disaccharidase deficiency
  - Zinc deficiency in school children & growth retardation
  - Persistent gastrointestinal symptoms
- Jaundice: due to obstruction of gall bladder

Diagnosis

Microscopy of stool, duodenal aspirates

- Direct faecal smear: ideally 3 specimens from different days should be examined
  - both saline and iodine
- Concentration Methods:
  - ZnSo4 Floatation reveals cysts
  - Formol ether sedimentation
- Trophozoites in soft, diarrhoeic stool
- Cysts in formed stool

Diagnosis

- Entero test (string test) – gelatin capsule containing a nylon string with a weight swallowed by the patient. Free end of the string is fixed to the mouth. Capsule dissolves & the string is released in the duodenum. After overnight string is removed & bile stained mucus collected
- Trichrome & iron haematoxylin

Diagnostic notes

- Although in severe infections the trophozoites or cysts can usually be found in the faeces, they may be very sparse in chronic infections

- The trophozoites can sometimes be obtained via a duodenal aspirates

- Culture
  - Not done routinely
  - Diamonds medium

Diagnostic notes cont.

- Serological methods have also been developed

- An enzyme-linked immunosorbent assay (ELISA) to detect IgM in serum provides evidence of current infection

- A polyclonal antigen-capture ELISA can be used to demonstrate submicroscopic infections in faeces and an IgA-based ELISA will detect specific antibodies in saliva

- Molecular diagnosis
  - DNA probes & PCR for research purposes

Treatment

1. Nitroimidazole derivatives

   - Metronidazole (Flagyl) – contraindicated in pregnancy???

   - Tinidazole

2. Acridine dye

   - Atabrine (quinacrine)

3. Nitrofurans

   - Furazolidone

Epidemiology of Giardiasis

1. World wide: Leningrad's curse, traveller's diarrhoea

2. Groups, families, person-person

- 100% in day care centers, asylums, holiday resorts, homosexuals, mountain streams

3. Warmer climate

4. Mostly waterborne, cross-confluence of municipal water supplies and mountain streams

Epidemiology of Giardiasis

- About 280 million people worldwide with symptomatic giardiasis
- Global rates of giardiasis, 1 – 7 % (developed world) & 30% or more (in developing world)
- 10% of those infected have no symptoms
- Person-to-person spread is common,
  - with 25% of family members with infected children themselves becoming infected

Prevention and control

1. Personal hygiene among over crowded population, families or groups, use of iodine

   - Wash hands thoroughly with soap and water i.e. after using the toilet, before handling or eating food

2. Sanitary disposal of human excreta

3. Proper composting of night soil

Prevention and control

4. Avoid food & water that might be contaminated

5. Boil drinking water or add Iodine tablets & not Chlorine

Prognosis

- Generally excellent
- Most patients are asymptomatic
- Most infections are self-limited
- Giardiasis is not associated with mortality except in rare cases of extreme dehydration, primarily in infants or malnourished children

Thank You