03 Intestinal & Luminal Protozoa

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Teaching Learning Outcomes (TLOs)

1. Describe the biology of protozoa	• Morphology (measurement, shape) • Life cycle (stages, transmission, epidemiology, risk factors/ people at risks)
2. Enumerate the signs & symptoms, diagnosis and treatment of protozoan infection	• Signs & symptoms • Diagnosis • Treatment
3. Enumerate the prevention and control of protozoan infection	• Prevention • Control

List of medically important intestinal/ luminal protozoa

PHYLUM	PARASITE	DISEASE
1. Sarcomastigophora		
Subphylum Sarcodina	*i) Entamoeba histolytica*	Amoebiasis
Subphylum Mastigophora	*ii) Giardia lamblia/ intestinalis* *iii) Dientamoeba fragilis**	Giardiasis
2. Ciliophora	*iv) Balantidium coli*#	Balantidiasis
3. Apicomplexa		
Sporozoa	Coccidia *v) Cryptosporidium parvum* *vi) Isospora belli* *vii) Cyclospora cayetanensis*	 Cryptosporidiasis Isosporiasis/ Cystoisoporiasis Cyclosporiasis
4. Microspora	*viii)* Microsporidia	Microsporidiasis

i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

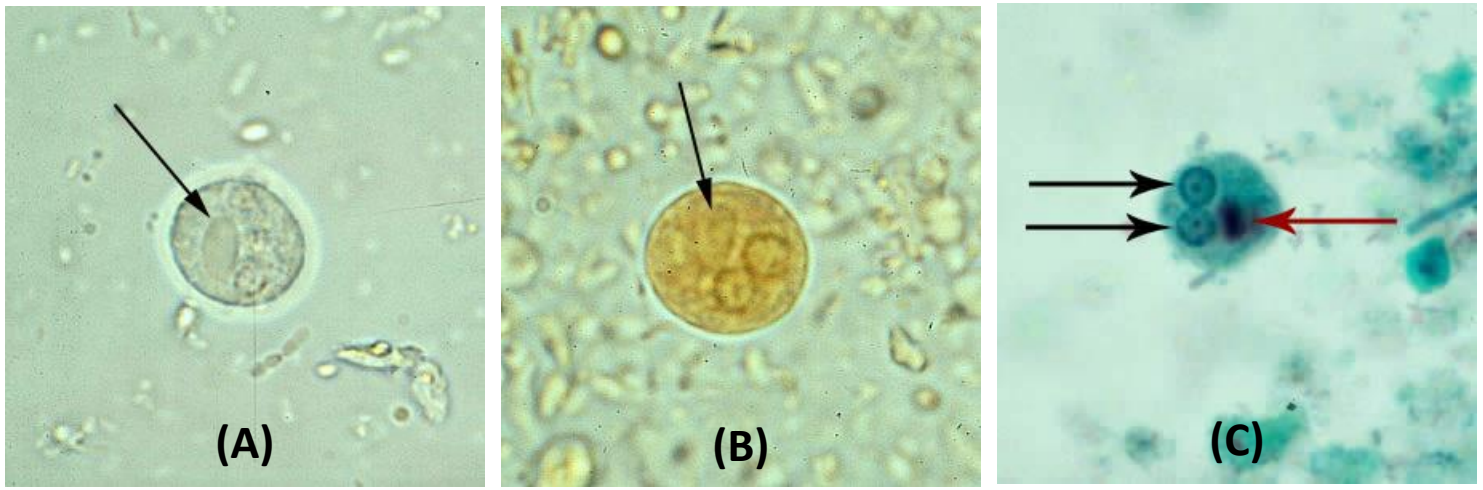
1 a. Morphology

Measurement (µm)

Cyst: 10 - 20

Trophozoite: 10 - 60

Shape: irregular



Cysts of *E. histolytica*/*E. dispar* in an unstained concentrated wet mount of stool **(A)**, in a concentrated wet mount stained with iodine **(B)** and stained with trichrome **(C)**. Refer to **(C)**, two to three nuclei are visible in the focal plane **(black arrows)** and the cysts contain chromatoid bodies with typically blunted ends **(red arrows)**. Notice the chromatoid bodies with blunt and rounded ends (black arrows)in image A & B

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Amebiasis_il.htm

i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
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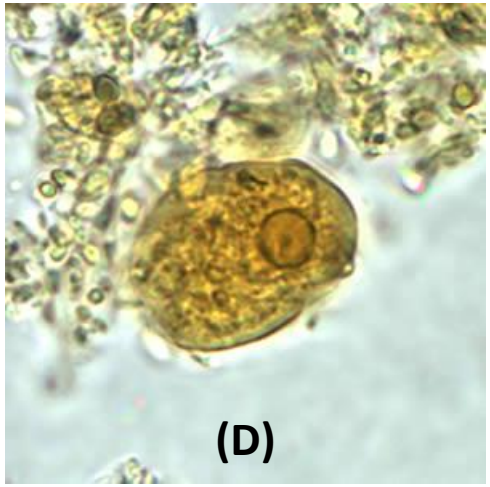
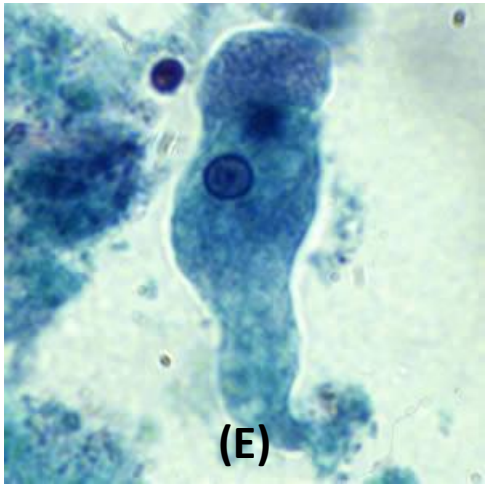
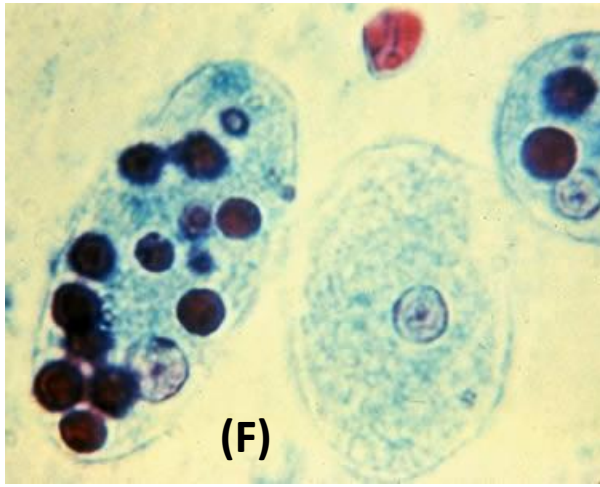
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

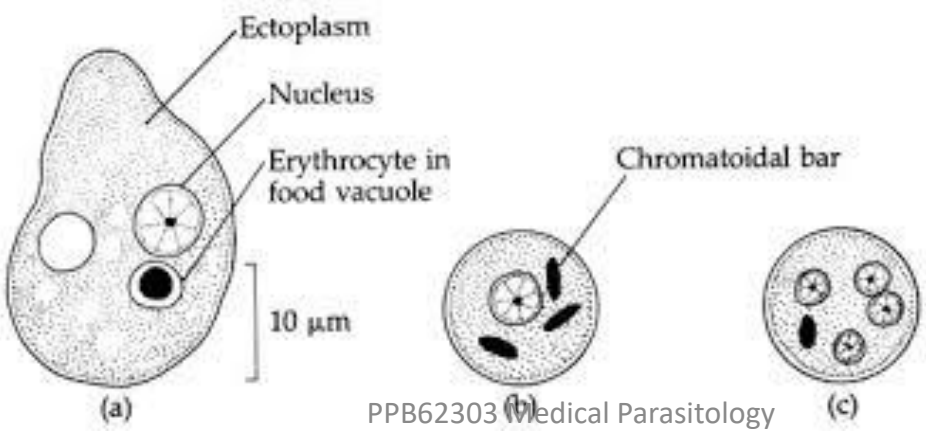
1 a. Morphology







Trophozoites of *E. histolytica*/*E. dispar* in a direct wet mount stained with iodine **(D)**, stained with trichrome **(E)** and with ingested erythrocytes stained with trichrome **(F)**.



i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Cyst: Infective & diagnostic stage

Trophozoite: Diagnostic stage; Infective in extraintestinal disease

Transmission: Faecal-oral route, exposure to faecal materials

Epidemiology: Worldwide, higher incidence in developing countries

Risk factors:

i. Practice homosexuality
ii. Travelers to developing countries
iii. Recent immigrants from developing countries
iv. Institutionalized populations

i) *Entamoeba histolytica*

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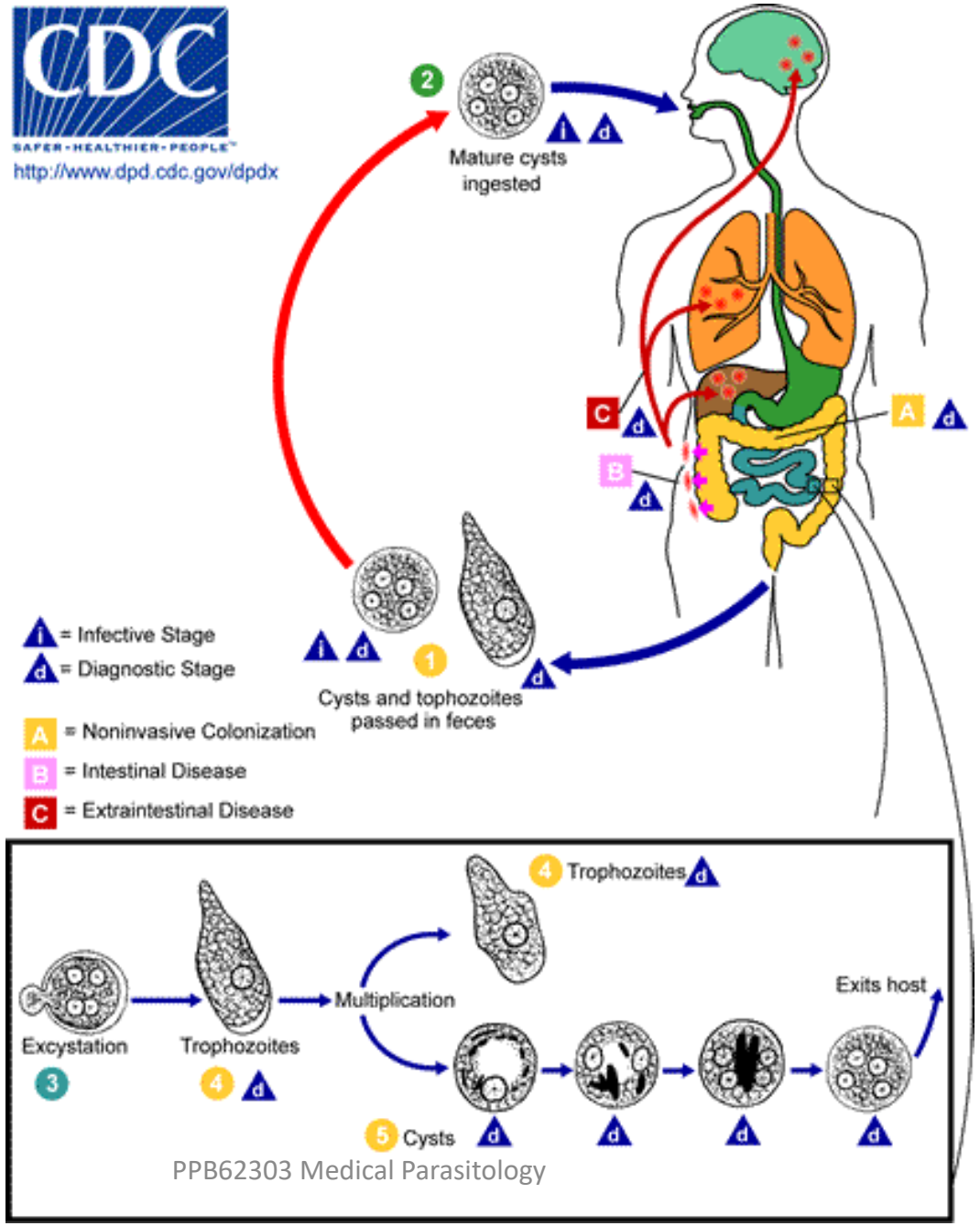

i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Loose faeces, stomach pain and stomach cramping.
- **Amoebic dysentery**: a severe form of amoebiasis associated with stomach pain, bloody stools (poop), and fever.
- Rarely, *E. histolytica* invades the liver and forms an abscess (a collection of pus).
- In a small number of instances, it has been shown to spread to other parts of the body, such as the lungs or brain, but this is very uncommon

i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Fresh stool: wet mounts and permanently stained preparations
- Concentrates from fresh stool (not useful: trophozoite)
- Aspirates or biopsy samples obtained during colonoscopy or surgery
- Nonpathogenic *E. dispar*, is morphologically identical to *E. histolytica*
- Microscopic finding: *E. histolytica/dispar*
- Differentiation: based on isoenzymatic or immunologic analysis, molecular diagnosis

i) *Entamoeba histolytica*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 c. Treatment

- For asymptomatic infections:

  Drugs of choice: iodoquinol, paromomycin, or diloxanide furoate

- For symptomatic intestinal disease or extraintestinal infections (e.g.: hepatic abscess):

  metronidazole or tinidazole, immediately followed by treatment with iodoquinol, paromomycin, or diloxanide furoate.

i) *Entamoeba histolytica*

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2. Enumerate the
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b. diagnosis
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of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

3 a. Prevention b. control

- Address the primary mode of transmission (Ingestion of faecally contaminated food or water)
- Filtering or purifying drinking water (iodine or boiling) in endemic areas
- Wash: fruits and vegetables that may have been contaminated by the use of faecal material as fertilizer.
- Improved sanitation: to reduce the likelihood of transmission
- Travelers to endemic areas: reduce the risk of infection by drinking bottled water, not using ice cubes in drinks, and washing fruits and vegetables with clean water

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control
of protozoan infection

1 a. Morphology

Measurement (µm)

Cyst: Length: 8 – 18 Width: 7 – 10

Trophozoite: Length: 9 – 20 Width: 5 – 15

Shape: Cyst: oval/ ellipsoidal; Trophozoite: oval to pear shape

Cysts of *Giardia lamblia/ intestinalis* in wet mount viewed using differential interference contrast (DIC) microscopy **(A)**, stained with iodine **(B)** and trichrome **(C)** respectively.

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Giardiasis_il.htm

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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a. symptoms
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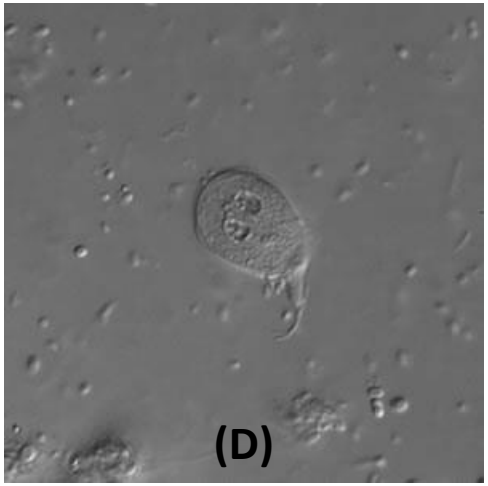
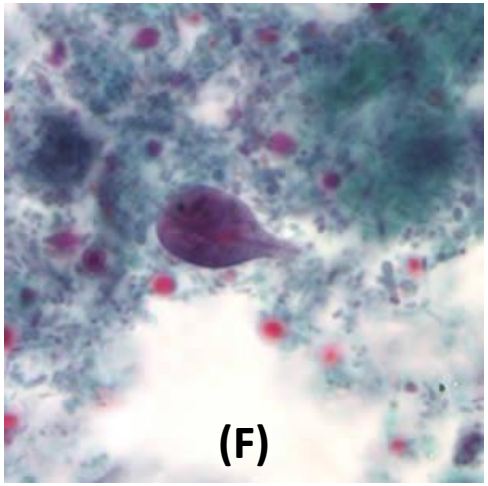
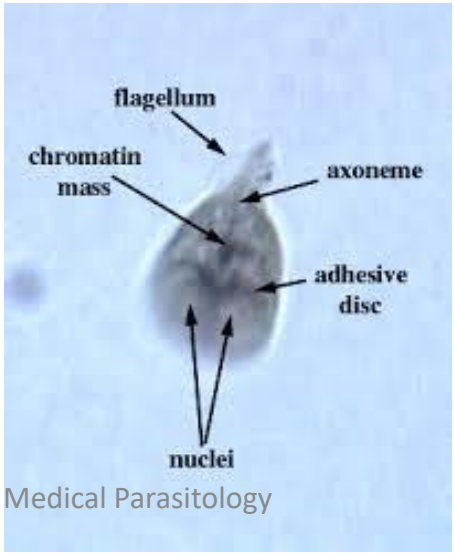
b. control of protozoan infection

1 a. Morphology





Trophozoites of *Giardia lamblia/ intestinalis* in wet mount viewed using differential interference contrast (DIC) microscopy (D), stained with iodine (E) and trichrome (F) respectively.



ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Cyst: Infective & diagnostic stage

Trophozoite: Diagnostic

Transmission: Faecal-oral route, waterborne, food borne

Epidemiology: Global disease

- **Risk factors:**
  i. Travelers to countries where giardiasis is common
  ii. People in child care settings
  iii. Those who are in close contact with someone who has the disease
  iv. People who swallow contaminated drinking water
  v. Backpackers or campers who drink untreated water from lakes or rivers
  vi. People who have contact with animals who have the disease

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

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2. Enumerate the
a. symptoms
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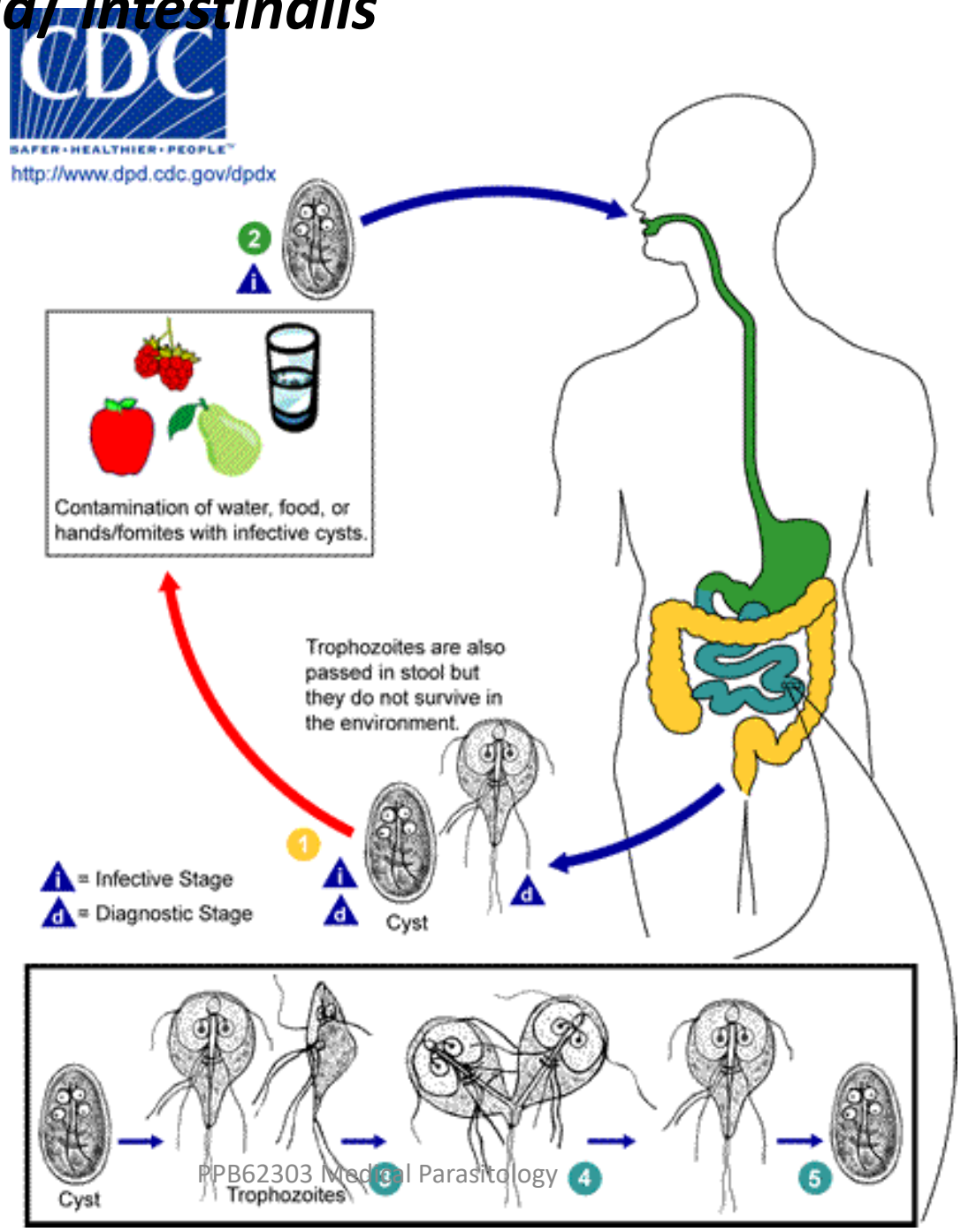
3. Enumerate the
a. prevention
b. control of protozoan infection



ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Asymptomatic
- Last for 1 to 2 weeks or longer
- Acute symptoms:
  i. Diarrhoea
  ii. Gas
  iii. Greasy stools that tend to float
  iv. Stomach or abdominal cramps
  v. Upset stomach or nausea/vomiting
  vi. Dehydration (loss of fluids)
- Chronic symptoms:
  i. Recurrent symptoms
  ii. Malabsorption

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Identification of cysts or trophozoites in the faeces
- Antigen detection tests by enzyme immunoassays
- Detection of parasites by immunofluorescence

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 c. Treatment

- Effective treatment:
  - i. Metronidazole,
  - ii. Tinidazole
  - iii. Nitazoxanide
- Alternative treatment:
  - i. Paromomycin
  - ii. Quinacrine
  - iii. Furazolidone

ii) *Giardia lamblia/ intestinalis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

3 a. Prevention b. control

- Proper hand washing practice
- At child care facilities: to reduce the risk of spreading the disease, children with diarrhoea should be removed from child care settings until the diarrhoea has stopped
- Avoid water (drinking and recreational) or food that may be contaminated.
- Clean up after ill pets and people

Source: http://www.cdc.gov/parasites/giardia/prevent.html

iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

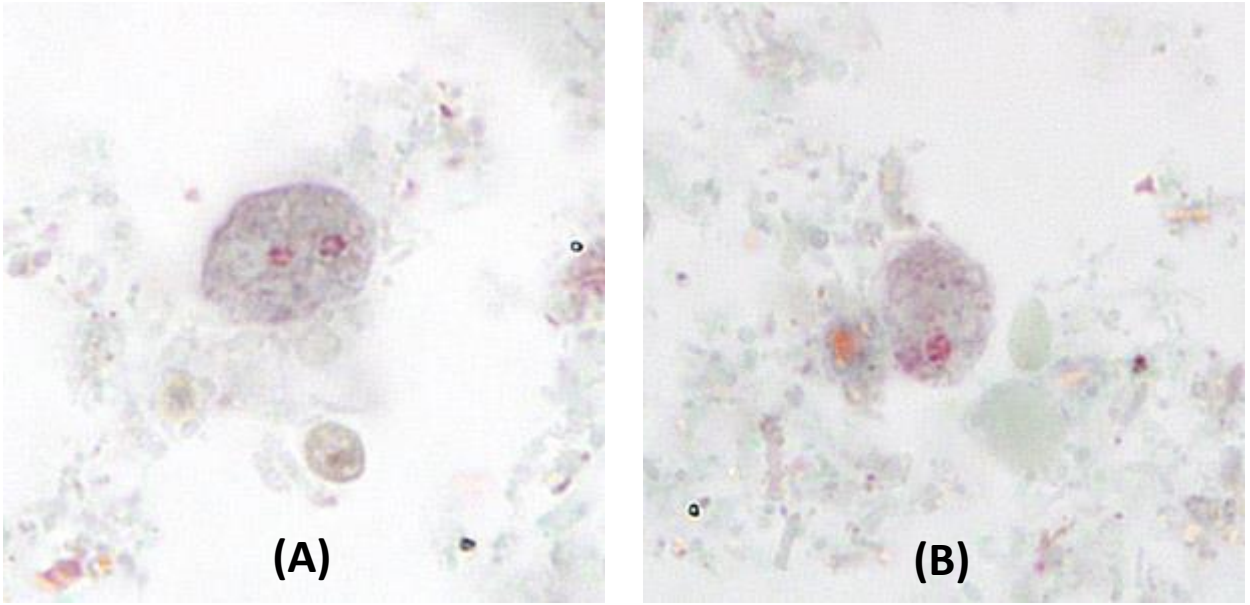
1 a. Morphology

Measurement (µm)

Cyst: have not been identified

Trophozoite: 5 - 16

Shape: irregular, contains a few karyosomes in a nucleus



Binucleate **(A)** and uninucleate **(B)** forms of a trophozoite of *D. fragilis* stained with trichrome.

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Dientamoeba_il.htm

iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: **Cyst:** have not been identified

Trophozoite: Infective & diagnostic

Transmission: Faecal-oral route

Epidemiology: Worldwide

Risk factors: Poor sanitary conditions

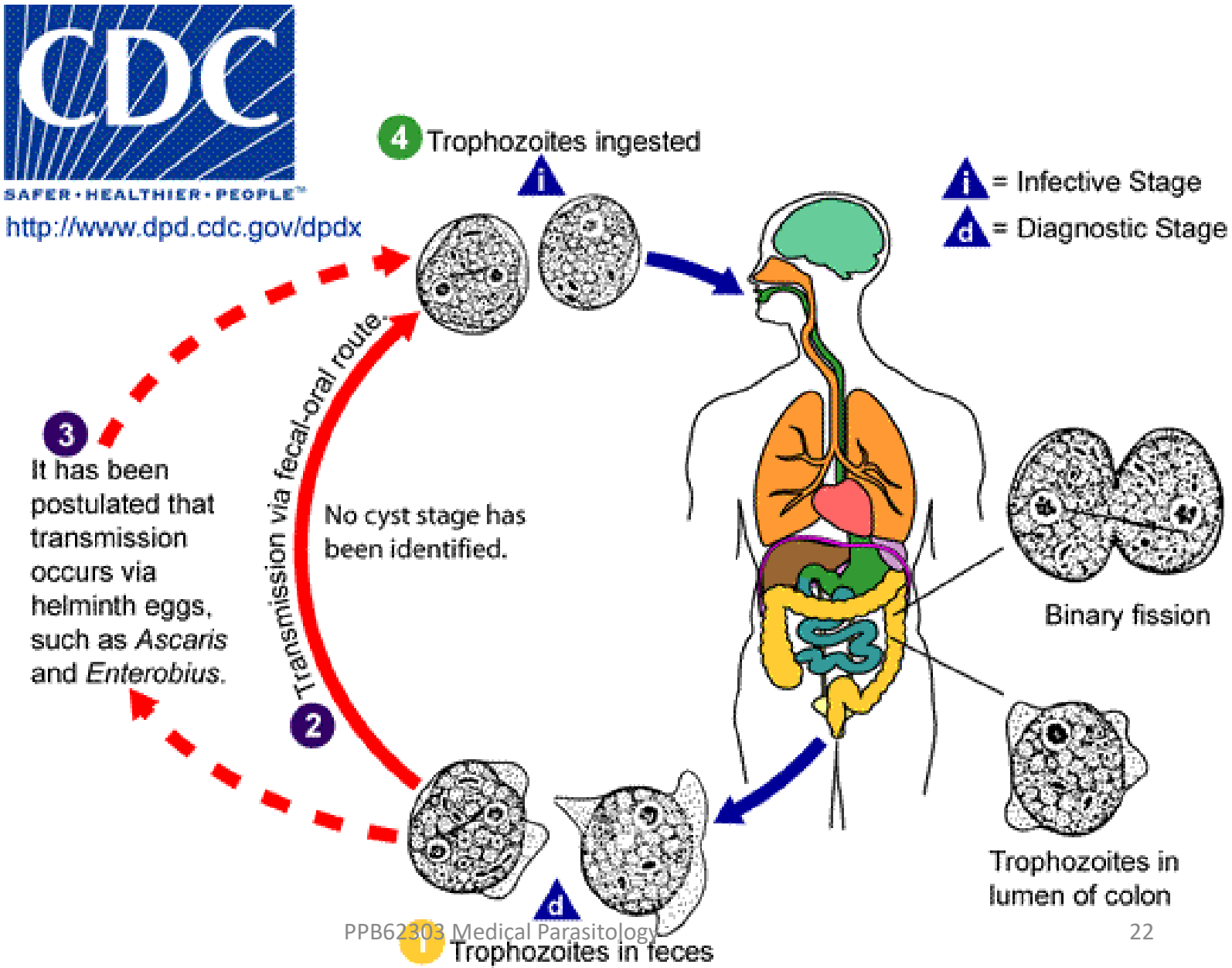
iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection



iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Diarrhoea
- Abdominal pain
- Loss of appetite
- Weight loss
- Nausea
- Fatigue

Source: http://www.cdc.gov/parasites/dientamoeba/faqs.html

iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Detection of trophozoites in permanently stained fecal smears
- Not detectable by stool concentration methods (cystic form is not identified)
- Pale-staining and nuclei may resemble those of *endolimax nana* or *E. Hartmanni*

iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 c. Treatment

- Drug of choice: iodoquinol
- Others:
  i. Paromomycin
  ii. Tetracycline (contraindicated in children under age 8, pregnant and lactating women)
  iii. Metronidazole

iii) *Dientamoeba fragilis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

3 a. Prevention b. control

i. Wash hands with soap and warm water before and after using the toilet, changing diapers; and preparing or eating food
ii. Teach children the importance of washing hands to prevent infection

vi) *Balantidium coli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

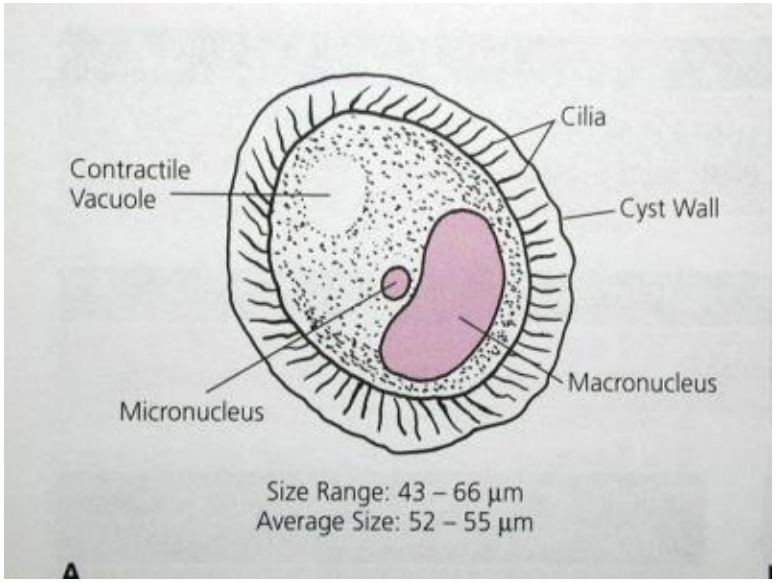
1 a. Morphology

Measurement (µm)

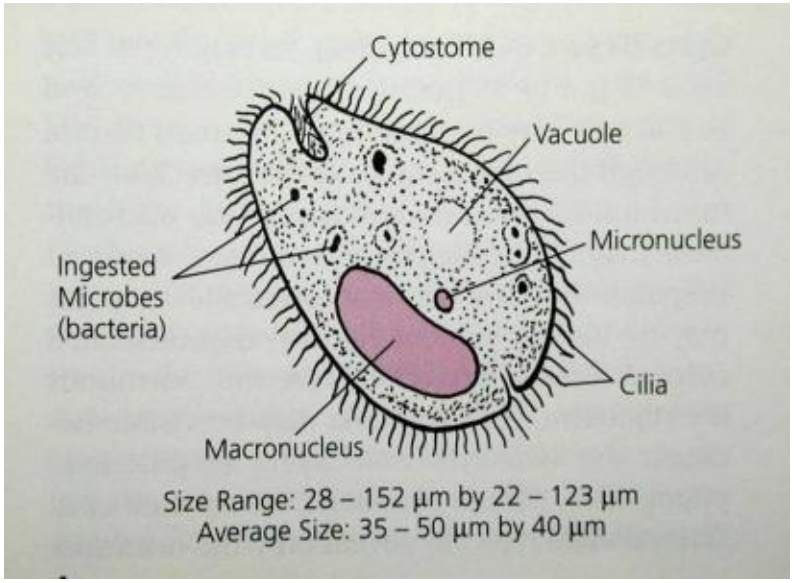
Cyst: 45 – 65

Trophozoite: Length: 30 – 100; Width: 30 - 80

Shape: Round to elliptical (C); oval (T)



(A)



(B)

Cyst **(A)** and trophozoite **(B)** of *B. coli*.

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Balantidiasis_il.htm
http://www.studydroid.com/printerFriendlyViewPack.php?packId=108106

vi) *Balantidium coli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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2. Enumerate the
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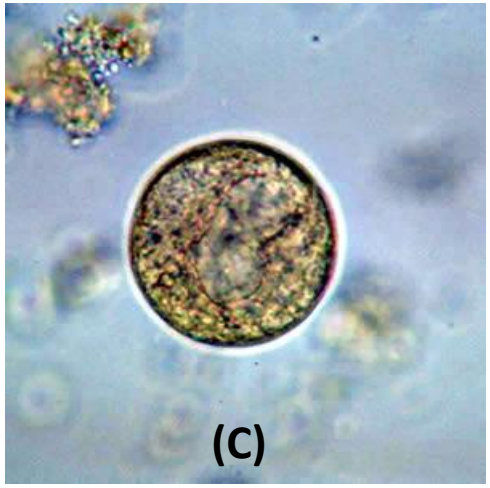
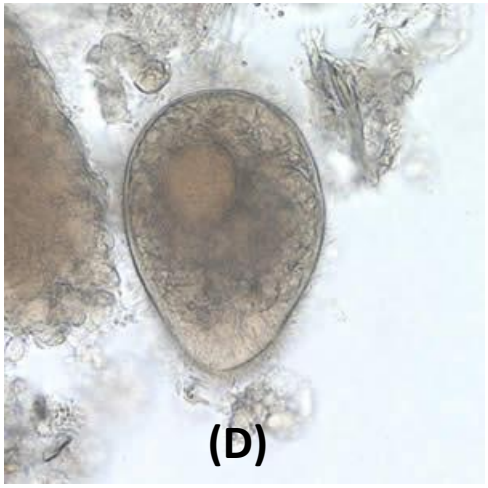
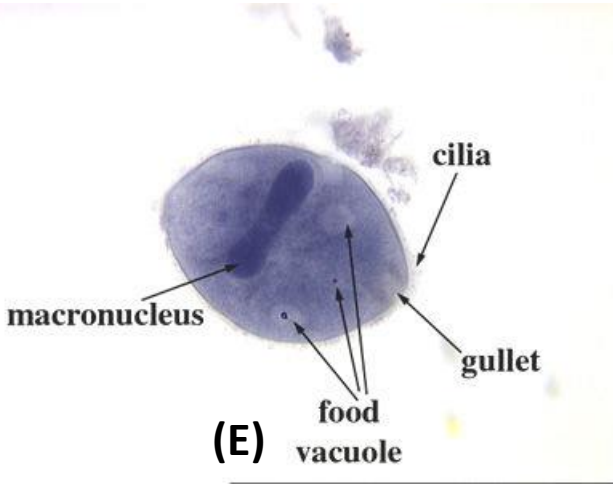
1 a. Morphology







Cyst **(C)** and trophozoite **(D)** of *B. coli* in wet mount preparation. Note the visible cilia on the cell surface.
Trichrome stained trophozoite of *B. coli* **(E)**.

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Balantidiasis_il.htm
http://vdshahane.hpage.co.in/gallery23622.html

vi) *Balantidium coli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Cyst: Infective, diagnostic

Trophozoite: Diagnostic

Transmission: Faecal-oral route, foodborne, waterborne

Epidemiology: Worldwide; pigs as reservoir

Risk factors: Pig handlers, poor sanitation

vi) *Balantidium coli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
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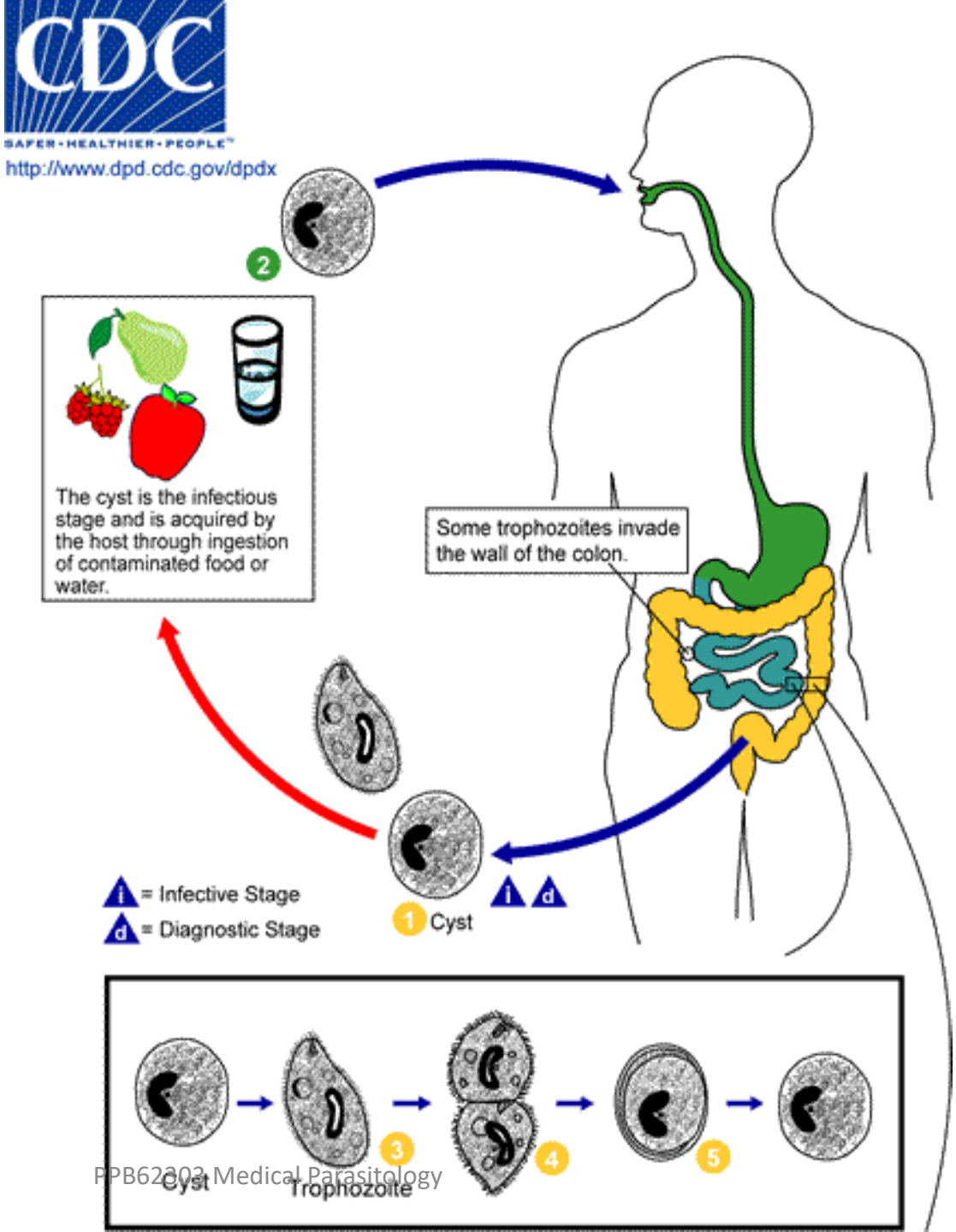

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2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Diarrhoea (watery, bloody, mucoid)
- Nausea
- Vomiting
- Abdominal pain
- Anorexia
- Weight loss
- Headache
- Mild colitis
- Fever
- Severe and marked fluid loss (resembling amebic dysentery)
- Dysenteric syndrome

Source: http://emedicine.medscape.com/article/213077-clinical

vi) *Balantidium coli*

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b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
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of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Detection of trophozoites in
  i. Stool specimens
  ii. Tissue collected during endoscopy

2 c. Treatment

- The drug of choice: tetracycline
- Alternative: metronidazole and iodoquinols

*Tetracycline is contraindicated in pregnancy and in children less than 8 years old

vi) *Balantidium coli*

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2. Enumerate the
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3. Enumerate the
a. prevention
b. control of protozoan infection

3 a. Prevention b. control

- Good hygiene practices
- Teach children the importance of washing hands to prevent infection
- Wash all fruits and vegetables with clean water when preparing or eating them, even if they have a removable skin

v) *Cryptosporidium parvum*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology

Measurement (µm)

Oocyst: 4 – 5

Shape: round

(A)

Cryptosporidium spp. oocysts **(pink arrows)** in wet mount. A budding yeast **(brown arrow)** is in the same field.

source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Cryptosporidiosis_il.htm

v) *Cryptosporidium parvum*

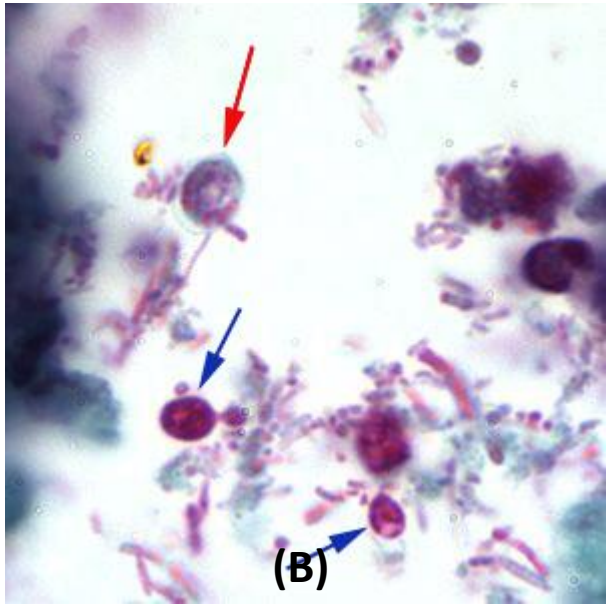
1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

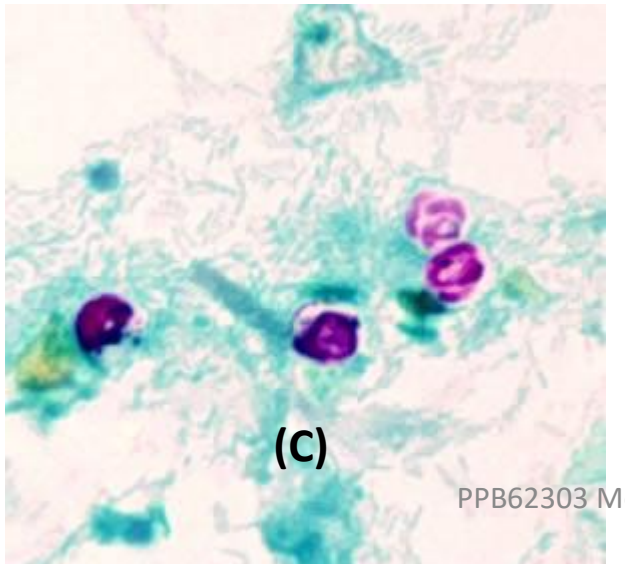
2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology



Cryptosporidium sp. oocysts stained with trichrome **(B)**. Oocysts may be detected, but should not be confirmed by this method. Trichrome staining is inadequate for a definite diagnosis because oocysts will appear unstained. Here the *Cryptosporidium* oocysts are represented by **red** arrows; the **blue** arrows represent yeast.



Cryptosporidium parvum oocysts stained with modified acid-fast **(C)**. Against a blue-green background, the oocysts stand out in a bright red stain. Sporozoites are visible inside the two oocysts to the right.

v) *Cryptosporidium parvum*

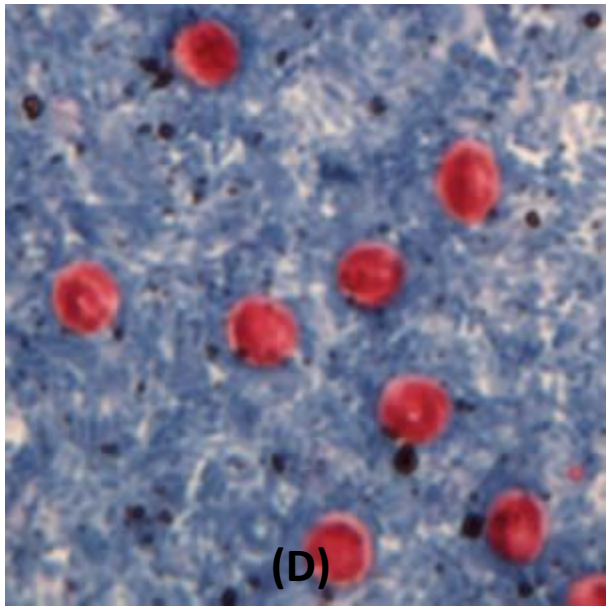
1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology



Cryptosporidium sp. oocysts stained with Ziehl-Neelson modified acid-fast **(D)**.

v) *Cryptosporidium parvum*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, people at risk)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: oocyst: Infective & diagnostic

- Sporozoites
- Trophozoite
- Type I meront
- Type II meront
- Merozoites
- Undifferentiated gamont
- Macrogamont
- Microgamont
- Microgametes
- Zygote
- Thin-walled oocyst (sporulated)
- Thick-walled oocyst (sporulated)

v) *Cryptosporidium parvum*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, people at risk)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Transmission: Faecal-oral route, foodborne, waterborne

Epidemiology: Worldwide; Milwaukee 1993 (0.4 million affected)

People at risk:

i. Children who attend day care centers, including diaper-aged children
ii. Child care workers
iii. Parents of infected children
iv. People who take care of other people with cryptosporidiosis
v. International travelers
vi. Backpackers, hikers, and campers who drink unfiltered, untreated water
vii. People who drink from untreated shallow, unprotected wells
viii. People, including swimmers, who swallow water from contaminated sources
ix. People who handle infected cattle
x. People exposed to human faeces through sexual contact

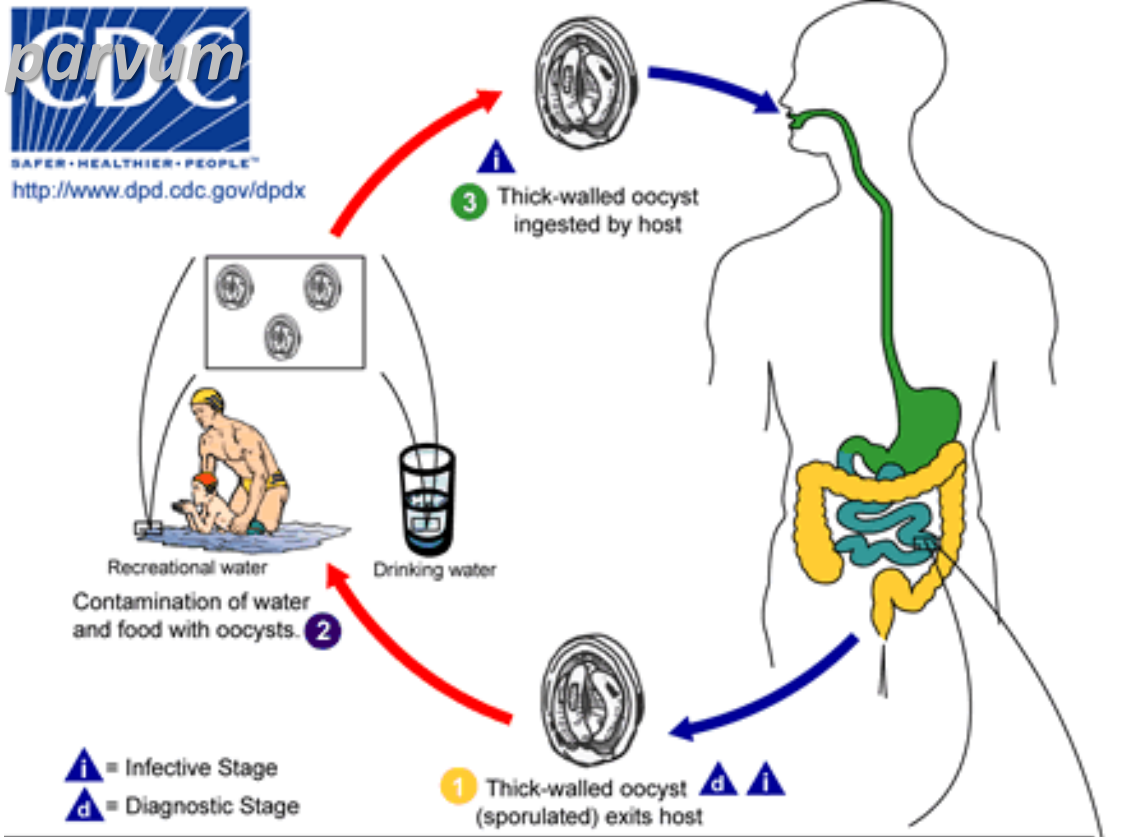
v) *Cryptosporidium parvum*

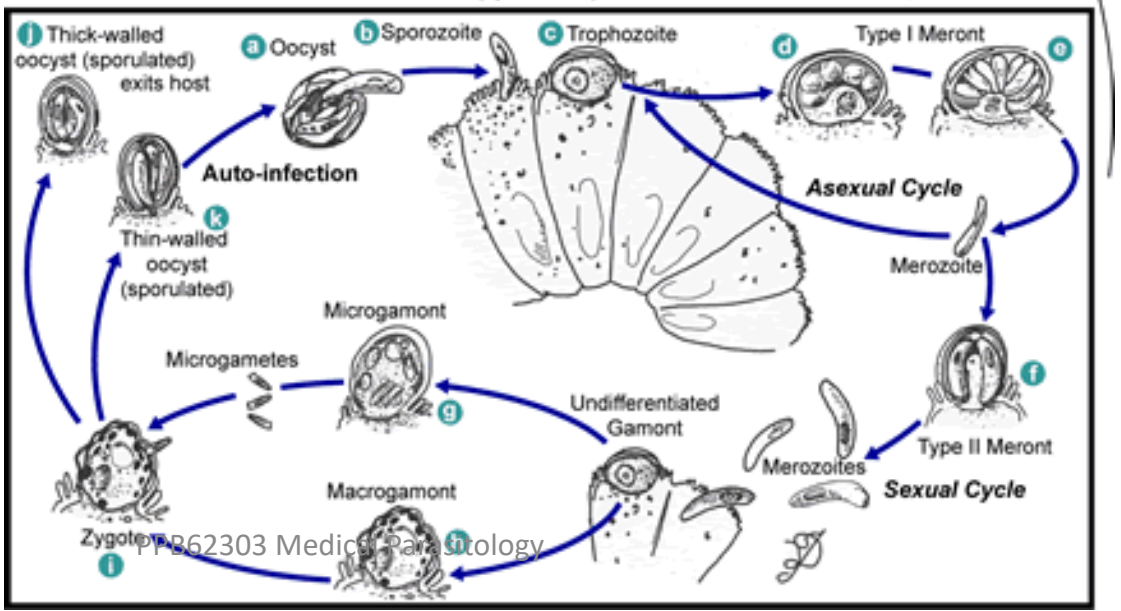
1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection





v) *Cryptosporidium parvum*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Asymptomatic
- Symptoms generally begin 2 to 10 days (average 7 days) after becoming infected with the parasite
- The most common symptom of cryptosporidiosis is watery diarrhoea
- Other symptoms include:
  i. Stomach cramps or pain
  ii. Dehydration
  iii. Nausea
  iv. Vomiting
  v. Fever
  vi. Weight loss

v) *Cryptosporidium parvum*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Acid-fast staining methods
- Immunofluorescence microscopy
- Molecular methods

2 c. Treatment

- Rapid loss of fluids because of diarrhoea can be managed by fluid and electrolyte replacement
- Immunocompetent: Nitazoxanide
- Immunocompromised(AIDS): anti-retroviral therapy

3 a. Prevention b. control

- Practise good hygiene
- Avoid food and water that might be contaminated
- Practice extra caution while traveling

vi) *Isospora belli* (*currently known as* *Cystoisospora belli*)

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

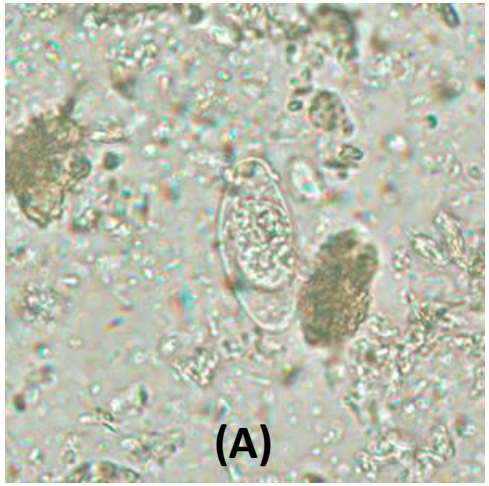
3. Enumerate the
a. prevention
b. control
of protozoan infection

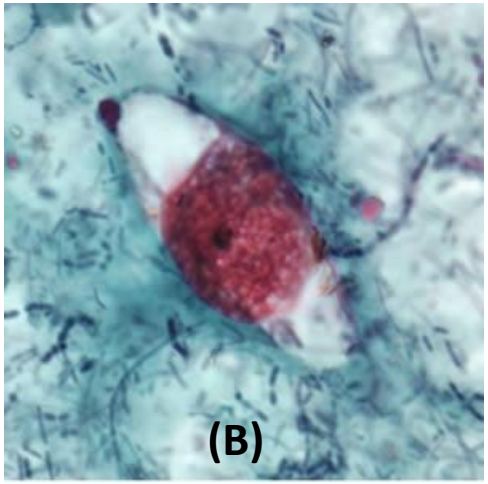
1 a. Morphology

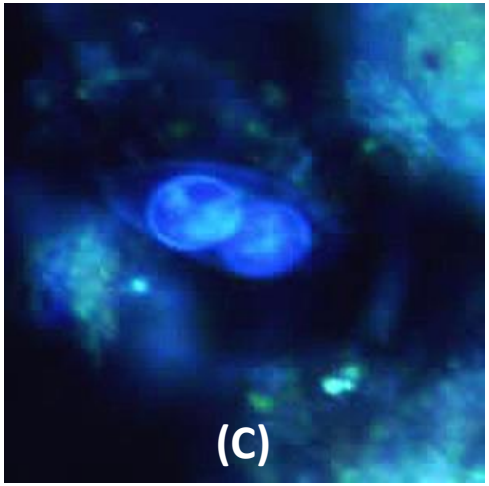
Measurement (µm)

Oocyst: 25 – 30 (large)

Shape: typical ellipsoid (~ oval)







Immature oocyst of *C. belli* in an unstained wet mount **(A)**, stained with safranin **(B)** containing a single sporoblast.
Immature oocyst of *C. belli* viewed under ultraviolet (UV) fluorescent microscopy, showing two sporoblasts **(C)**.

Source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Cystoisosporiasis_il.htm

vi) *Isospora belli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Oocyst: mature oocyst (Infective); Immature (diagnostic)

- Immature oocyst with sporoblasts
- Immature oocyst with sporocysts
- Mature oocyst with sporozoites
- Sporozoites
- Schizont
- Merozoites
- Microgametes
- Macrogametes

Transmission: Ingestion of contaminated food or water

Note: i. Immature oocyst needs 1-2 day in the environment to mature (become infective)

ii. Unlikely to pass directly from one person to another

Epidemiology: Worldwide, especially in tropical and subtropical areas

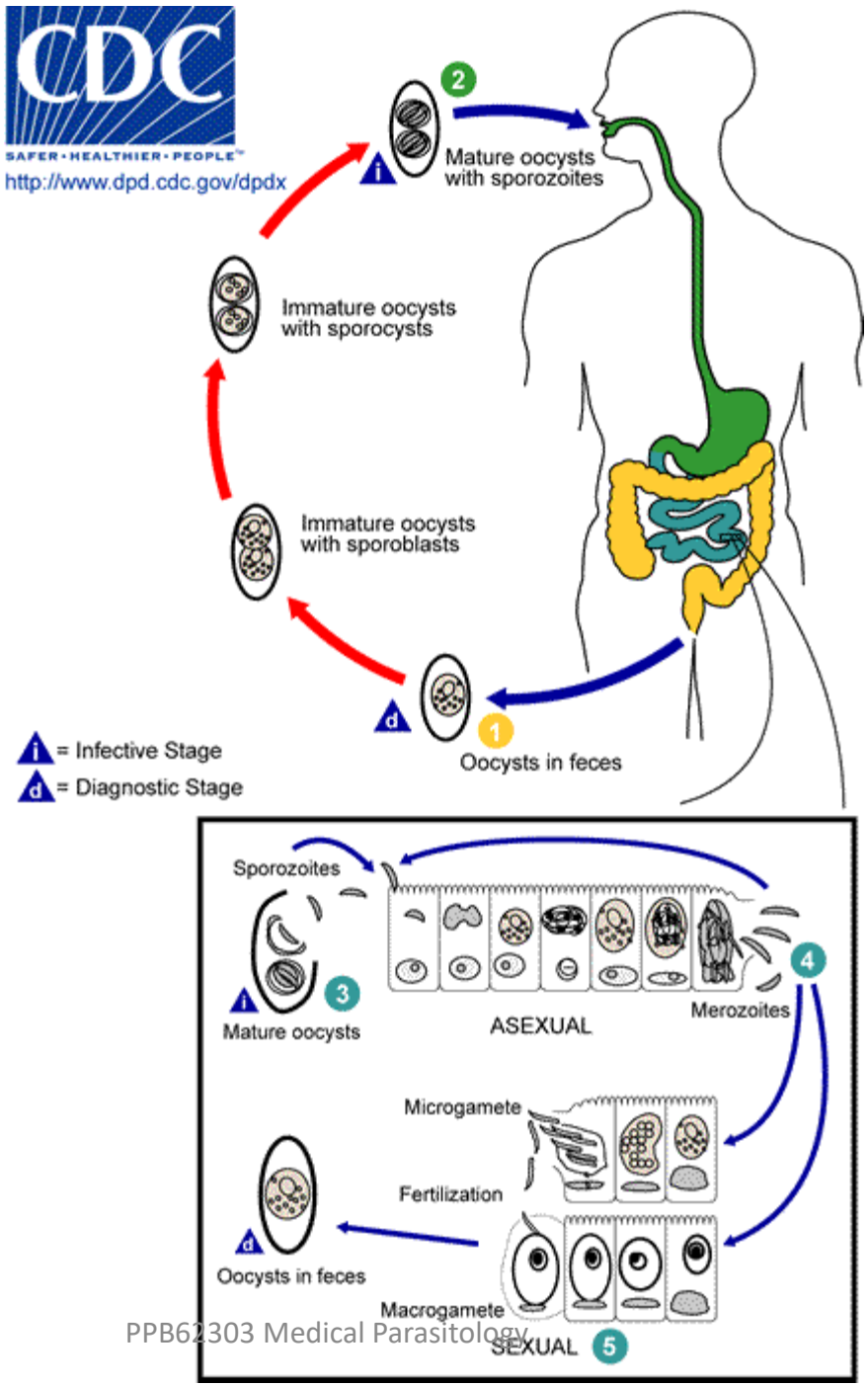
vi) *Isospora belli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection



vi) *Isospora belli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Acute, watery, non bloody diarrhoea (last for weeks)
- Crampy abdominal pain (last for weeks)
- [malabsorption and weight loss]
- Eosinophilia

  ** eosinophil count in the peripheral blood > 0.45×10^9/L (450/µl)
- Loss of appetite
- Nausea
- Vomiting
- Fever

vi) *Isospora belli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Demonstration of the large, typically shaped oocysts
- Oocysts are autofluorescent → ultraviolet (UV) fluorescence microscope
- Examination of duodenal specimens by biopsy or string test

2 c. Treatment

- Drug of choice: trimethoprim-sulfamethoxazole (TMP-SMX)

  - Trade name: Bactrim, Septra and Cotrim
- Alternative: Pyrimethamine
- Second line alternative: Ciprofloxacin

vi) *Isospora belli*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

3 a. Prevention b. control

- Avoiding food or water that might be contaminated with stool
- Good hand washing and personal-hygiene practices
- Teach children the importance of washing hands to prevent infection

vii) *Cyclospora cayentanensis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

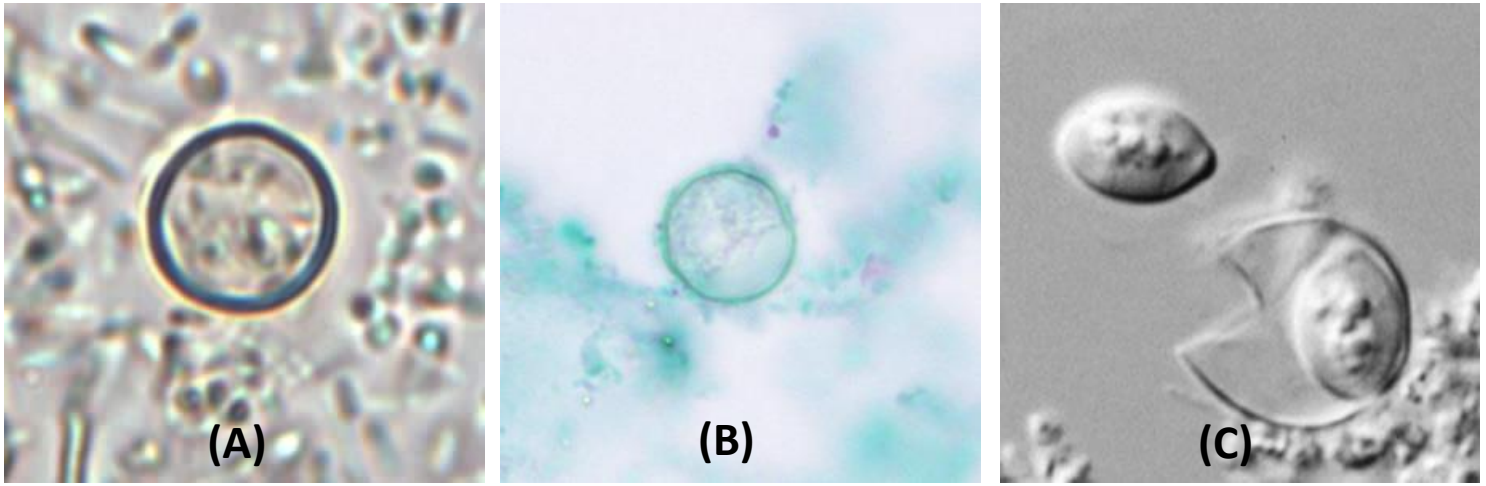
3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology

Measurement (µm)

Oocyst: 7.5 – 10

Shape: spherical



Oocysts of *C. cayetanensis* in unstained wet mounts **(A)**, trichrome stain **(B)**.
C: Rupturing oocyst of *C. cayetanensis* viewed under DIC microscopy. One sporocyst has has been released from the mature oocyst; the second sporocyst is still contained within the oocyst wall.

Source: http://www.cdc.gov/parasites/cyclosporiasis/gen_info/faqs.html

vii) *Cyclospora cayentanensis*

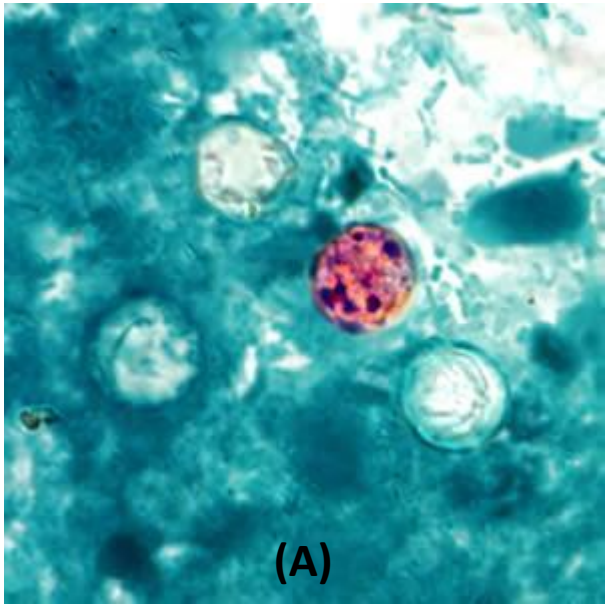
1. Describe the biology of protozoa

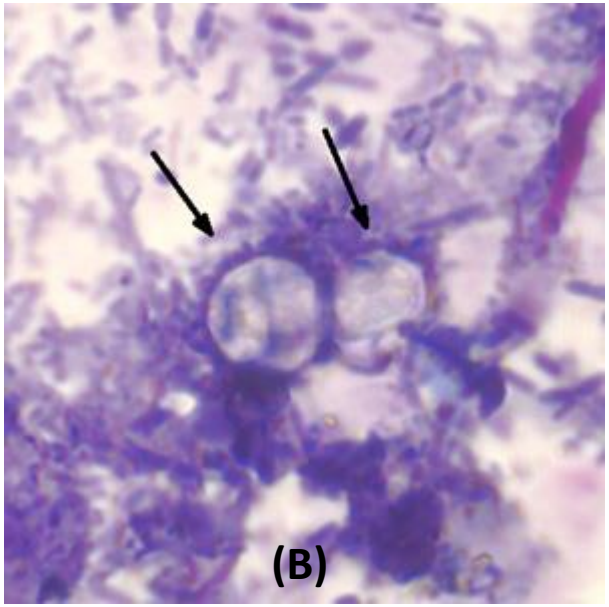
a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology





A: Oocysts of *C. cayetanensis* stained with modified acid-fast stain. Note the variability of staining in the four oocysts.
B: Two oocysts of *C. cayetanensis* stained with modified acid-fast stain. Both oocysts failed to take up the carbol fuschin stain.

vii) *Cyclospora cayentanensis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risks)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Sporulated oocyst: infective

Unsporulated oocyst: diagnostic

- Meront I
- Meront II
- Zygote

Transmission: foodborne, waterborne

Note: i. Immature oocyst needs time (days – weeks) in the environment to mature (become infective)

ii. Unlikely to pass directly from one person to another

Epidemiology: Common in tropical and subtropical regions

Risks: People living or traveling to tropical or subtropical regions

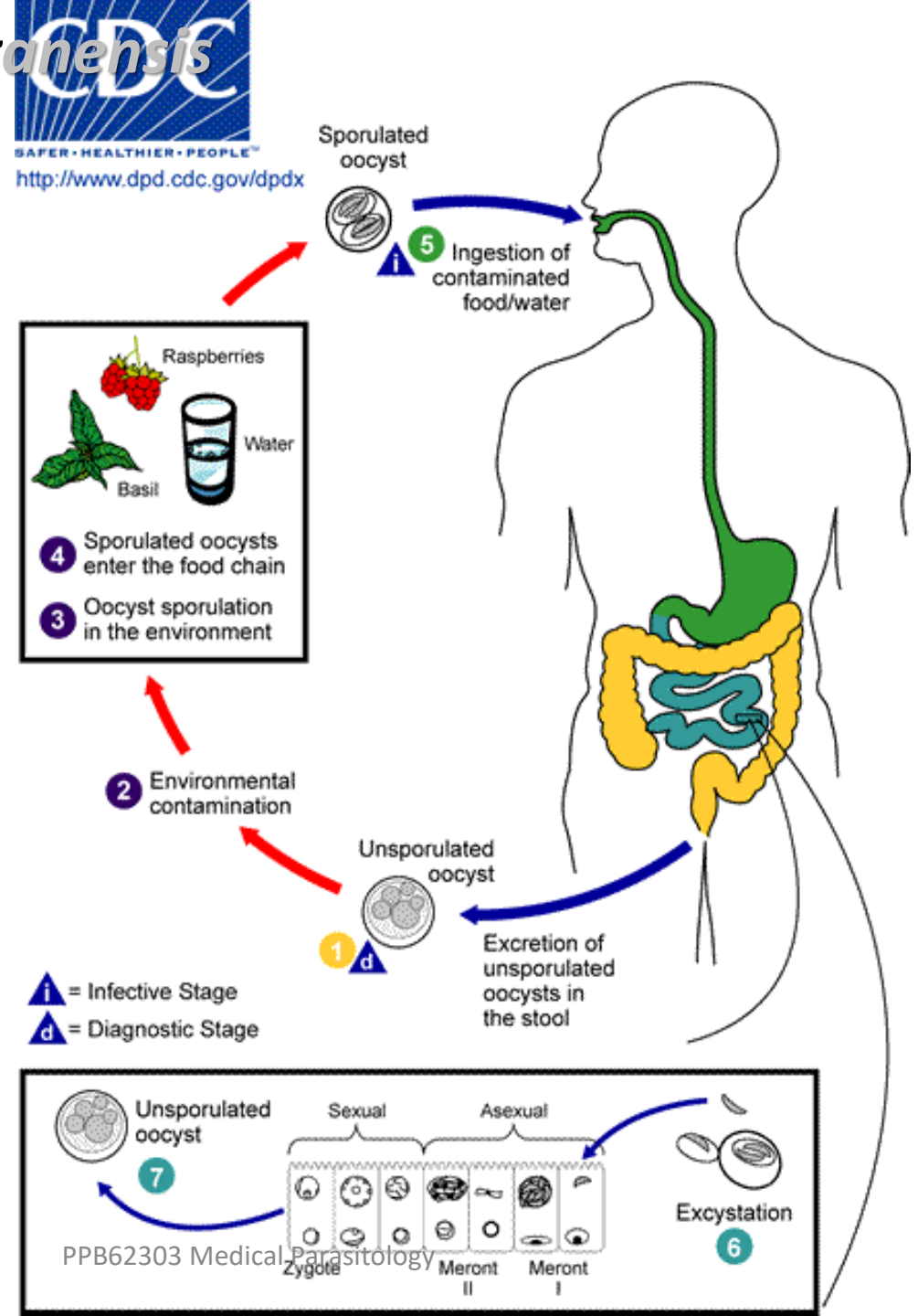
vii) *Cyclospora cayetanensis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection



Mero
Mero
Zygot

vii) *Cyclospora cayentanensis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Watery diarrhoea (most common)
- Loss of appetite
- Weight loss
- Cramping
- Bloating
- Increased gas
- Nausea
- Fatigue
- Vomiting (less common)
- Low-grade fever (less common)

Source: http://www.cdc.gov/parasites/cyclosporiasis/disease.html

vii) *Cyclospora cayentanensis*

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Acid-fast staining method
- *Cyclospora* oocysts are autofluorescent → ultraviolet (UV) fluorescence microscope

2 c. Treatment

- Combination of two antibiotics
- Trimethoprim-sulfamethoxazole (TMP-SMX)

3 a. Prevention b. control

- Avoid food or water that might have been contaminated with stool

Note:

i. Treatment with chlorine or iodine is unlikely to kill *Cyclospora* oocysts

ii. No vaccine is available for cyclosporiasis

Source: http://www.cdc.gov/parasites/cyclosporiasis/prevents.html
http://www.cdc.gov/parasites/cyclosporiasis/treatment.html

viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

15 microsporidian species that have been identified as human pathogens

1. *Anncaliia* (formerly *Brachiola*) *algerae*
2. *A. connori*
3. *A. vesicularum*
4. *Encephalitozoon cuniculi*
5. *E. hellem*
6. *E. intestinalis* (previously named *Septata intestinalis)*
7. *Enterocytozoon bieneusi*
8. *Microsporidium ceylonensis*
9. *M. africanum*
10. *Nosema ocularum*
11. *Pleistophora* sp.
12. *Trachipleistophora hominis*
13. *T. anthropophthera*
14. *Vittaforma corneae*
15. *Tubulinosema acridophagus*

source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Microsporidiosis_il.htm

viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

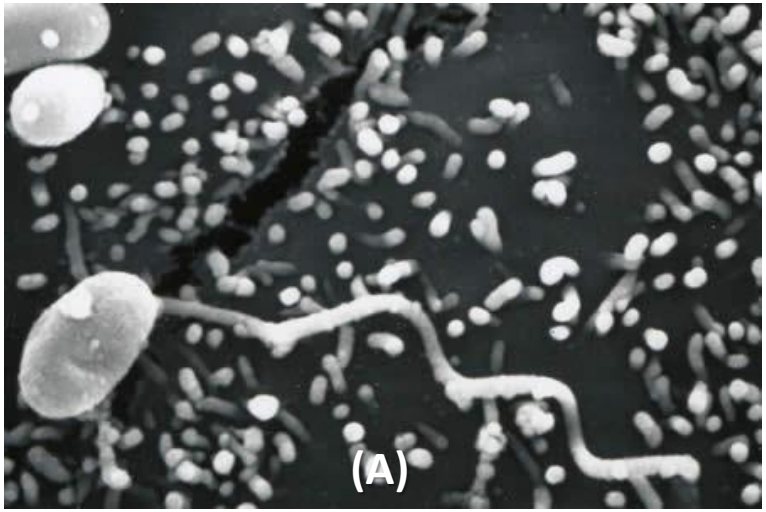
3. Enumerate the
a. prevention
b. control of protozoan infection

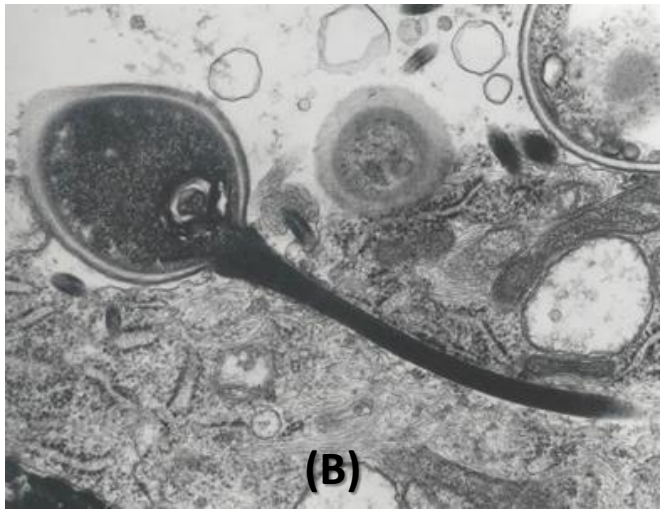
1 a. Morphology

Measurement

Spore: 1 – 4 µm

Shape: Oval, with a unique organelle, the polar tubule or polar filament





Scanning electron micrograph **(A)** and transmission electron micrograph **(B)** of a microsporidian spore with an extruded polar tubule inserted into a eukaryotic cell. The spore injects the infective sporoplasms through its polar tubule.

source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Microsporidiosis_il.htm

viii) Microsporidia

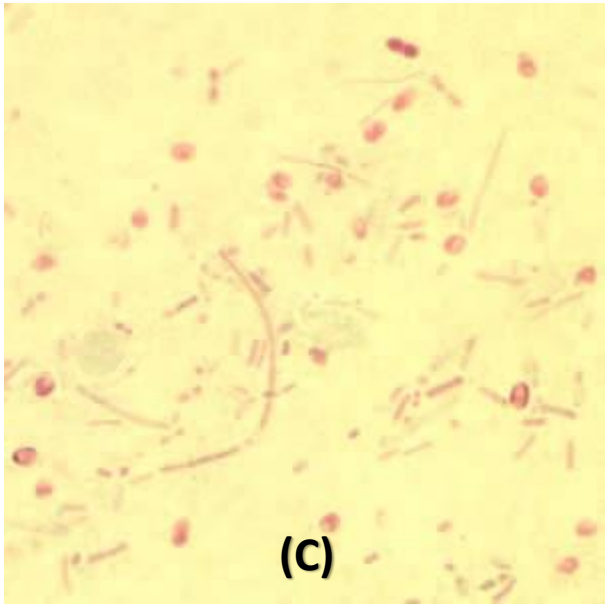
1. Describe the biology of protozoa

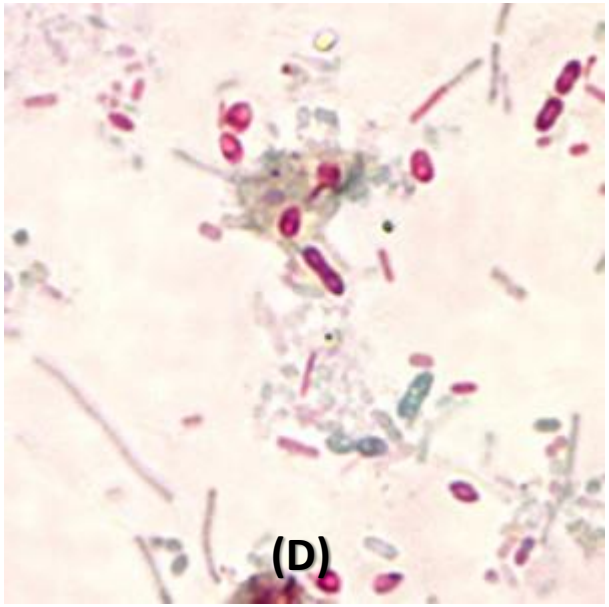
a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 a. Morphology





C: *Enterocytozoon bieneusi* spores stained with Chromotrope 2R.
D: Unidentified microsporidia stained with Chromotrope 2R.

source: http://www.dpd.cdc.gov/dpdx/HTML/ImageLibrary/Microsporidiosis_il.htm

viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, people at risk)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

1 b. Life cycle

Stages: Resistant spore : infective & diagnostic

Transmission: Foodborne, waterborne

Epidemiology: Opportunistic infectious agents worldwide

People at risks: Immumocompromised patients

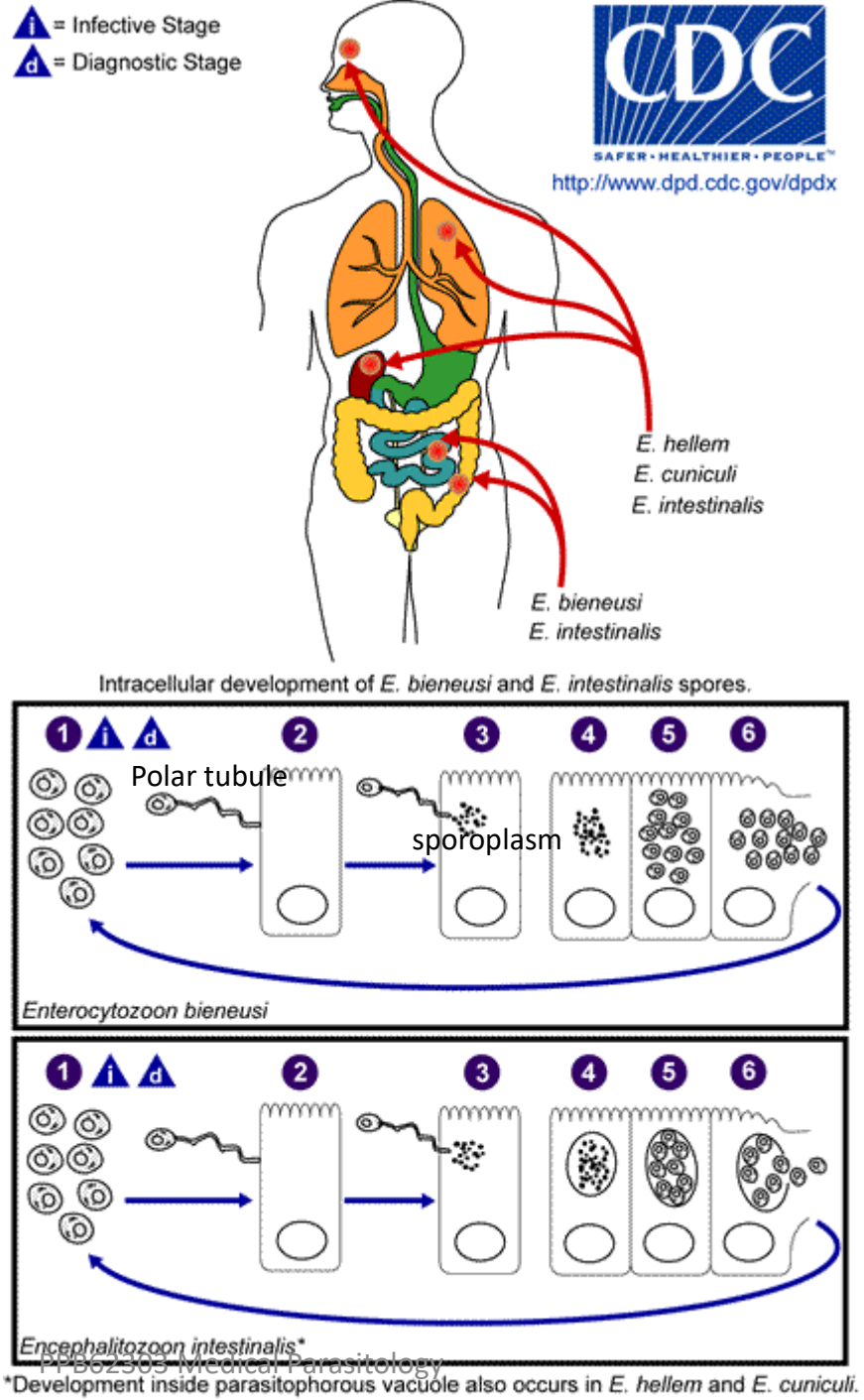
viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection



viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. signs & symptoms
b. diagnosis
c. treatment of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 a. Signs & symptoms

- Diarrhoea (most common)
- Clinical manifestations of microsporidiosis are very diverse, varying according to the causal species

Microsporidian species	Clinical manifestation
Anncaliia algerae	Keratoconjunctivitis, skin and deep muscle infection
Enterocytozoon bieneusi	Diarrhea, acalculous cholecystitis
Encephalitozoon cuniculi and *Encephalitozoon hellem*	Keratoconjunctivitis, infection of respiratory and genitourinary tract, disseminated infection
Encephalitozoon intestinalis (syn. *Septata intestinalis*)	Infection of the GI tract causing diarrhea, and dissemination to ocular, genitourinary and respiratory tracts
Microsporidium (*M. ceylonensis* and *M. africanum*)	Infection of the cornea
Nosema sp. (*N. ocularum*), *Anncaliia connori*	Ocular infection
Pleistophora sp.	Muscular infection
Trachipleistophora anthropophthera	Disseminated infection
Trachipleistophora hominis	Muscular infection, stromal keratitis, (probably disseminated infection)
Tubulinosema acridophagus	Disseminated infection
Vittaforma corneae (syn. *Nosema corneum*)	Ocular infection, urinary tract infection

viii) Microsporidia

1. Describe the biology of protozoa

a. Morphology (measurement, shape)
b. Life cycle (stages, transmission, epidemiology, risk factors)

2. Enumerate the
a. symptoms
b. diagnosis
c. treatment
of protozoan infection

3. Enumerate the
a. prevention
b. control of protozoan infection

2 b. Diagnosis

- Microscopy (light, Scanning/Transmission Electron)
- Immunofluorescence assays (IFA)
- Molecular methods

2 c. Treatment

- Initiation or optimization of antiretroviral therapy

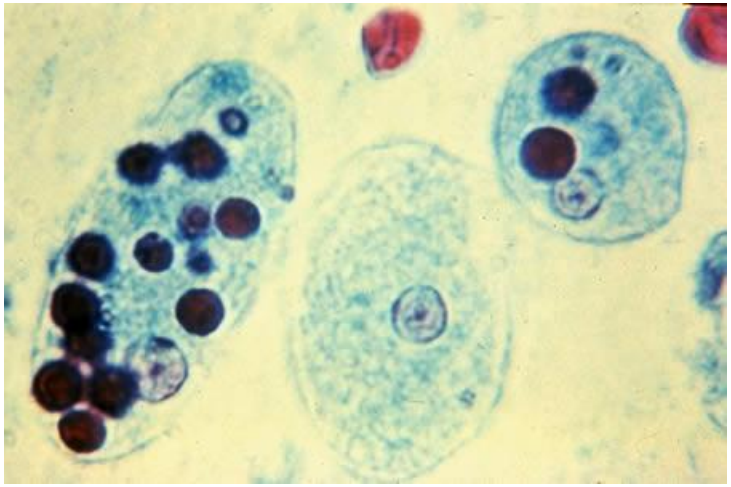
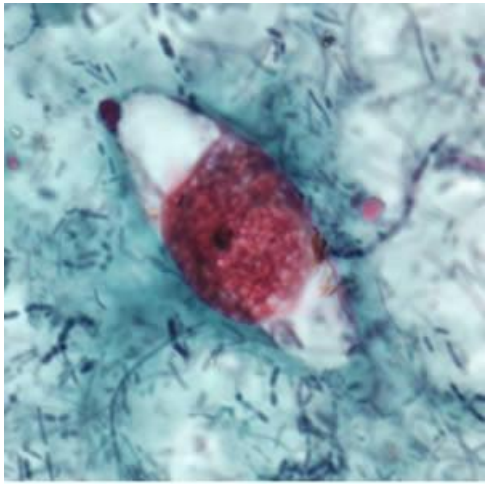
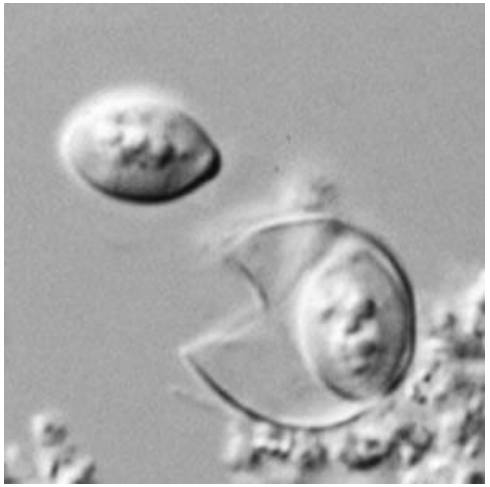
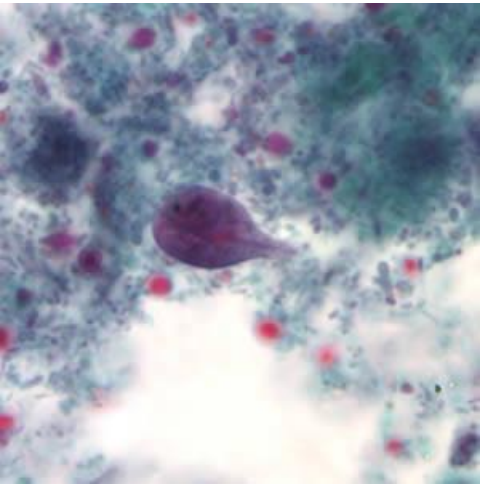
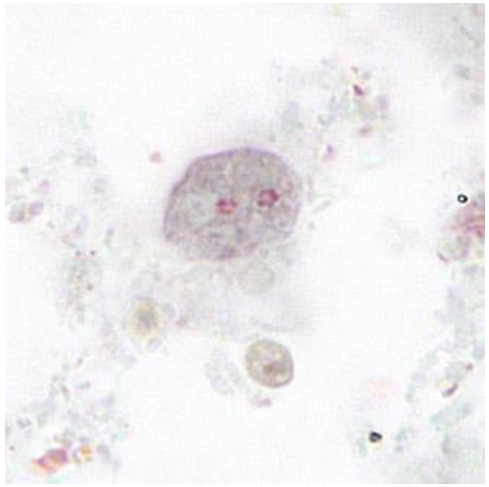
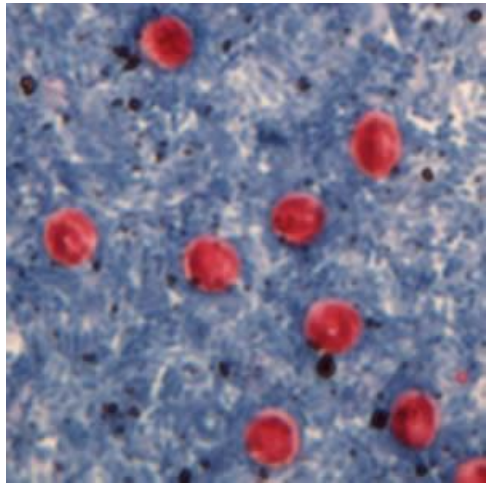
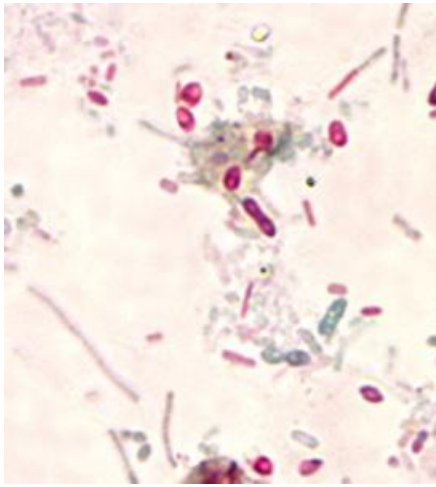
3 a. Prevention b. control

- Avoid food or water that might have been contaminated with stool
- Disinfect microsporidia in water*

Source: http://www.cdc.gov/dpdx/microsporidiosis/tx.html
** http://www.ncbi.nlm.nih.gov/pubmed/15567583*

Teaching Learning Outcomes (TLOs)

1. Describe the biology of protozoa	• Morphology (measurement, shape) • Life cycle (stages, transmission, epidemiology, risk factors/ people at risks)
2. Enumerate the signs & symptoms, diagnosis and treatment of protozoan infection	• Signs & symptoms • Diagnosis • Treatment
3. Enumerate the prevention and control of protozoan infection	• Prevention • Control


Thank you
Glossary of cell types
http://en.wikipedia.org/wiki/Apicomplexan_life_cycle