Coccidia

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Learning objectives

• After class, students will be able to:
  • Describe morphology, life cycle, signs and symptoms, prevention and control, laboratory diagnosis and treatment of coccidian of man and *Pneumocystis*
  • Differentiate oocysts of coccidian causing human infection
Coccidia

- Collectively intracellular organisms in suborder Eimeriorina in Phylum Apicomplexa
- 10 families, at least 42 genera, and over 2,000 named species
- Life history has both asexual and sexual phase of development
Asexual reproduction

From one cell to many cells

• Merogony or schizogony
• Endodyogeny, endopolygeny (internal budding)

1 Sporozoite
   ↓
1 Trophozoite
   ↓
1 meront or schizont
   ↓
Many merozoites
Sexual reproduction

• Sex cell production: **Gametogony**

- **Macrogamont** (macrogametocyte)
- **Microgamont** (microgametocyte)
- **Microgamete** (macrogamete)
- **Merozoite**
- **Zygote**

**fertilization**
Sexual reproduction

• Sporogony: production of sporozoites

1. Zygote
2. Oocyst (immature or unsporulated)
3. Sporozoite
4. Oocyst (mature or sporulated, infective)
Taxonomy of coccidia

• Based on number of sporocysts and sporozoites in sporulated oocyst

Unsporulated oocyst → Sporulated oocyst

Sporocysts

Sporozoites
Taxonomy - coccidia of medical importance

- **0+4 Cryptosporidium**
  - Naked sporozoites

- **2+4 Cyclospora**

- **2+8 Cystoisospora**
  - Toxoplasma
  - Sarcocystis
# Coccidia of medical importance

<table>
<thead>
<tr>
<th></th>
<th>Life cycle</th>
<th>Opportunis t</th>
<th>Affected organs/ Disease in man</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Toxoplasma gondii</strong></td>
<td>Complex Cat=DH</td>
<td>+</td>
<td>Brain-Toxoplastic encephalitis Developing organs- Congenital toxoplasmosis</td>
</tr>
<tr>
<td><strong>Sarcocystis</strong></td>
<td>Complex Cattle, pig=IH</td>
<td>-</td>
<td>Small intestine- Eosinophilic enteritis</td>
</tr>
<tr>
<td><strong>Cystoisospora belli</strong></td>
<td>Simple</td>
<td>+</td>
<td>Small intestine-Diarrhea</td>
</tr>
<tr>
<td><strong>Cryptosporidium</strong></td>
<td>Simple</td>
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</tr>
<tr>
<td><strong>Cyclospora cayetanensis</strong></td>
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</tbody>
</table>
Toxoplasma gondii

• Disease: toxoplasmosis
  • Congenital toxoplasmosis
  • Toxoplastic encephalitis in AIDS

• Stages in life cycle
  • Tachyzoites, 6 x 2 µm: during acute stage of infection
  • Bradyzoites, during chronic stage of infection
  • Oocyst, 10 x 12 µm

Sporulated oocyst
Life cycle

Enteroepithelial cycle
- Merogony
- Gametogony
- Fertilization

Sporulation

Asexual phase
- Bradyzoites
  - In tissue cysts
  - tachyzoites
  - sporozoites

rowdysites.msudenver.edu
Human infection

• Man acquires infection from
  • Consumption of improperly cooked meat (tissue cysts)
  • Drinking unfiltered water (oocysts)
  • Contaminated hand (oocysts)
  • Organ transplant, blood transfusion (tachyzoites)
Pathogenesis, Signs, Symptoms

• **Acute phase**- tachyzoites invade and destroy host cells
  • Lymphadenopathy, flu-like symptoms

• **Chronic phase**
  • Immune pressure: Tachyzoites → bradyzoites (tissue cysts) in brain, muscle, liver
  • Symptomless
• Reactivate in **AIDS** → toxoplasmic encephalitis
• **Congenital** toxoplasmosis: chorioretinitis, hydrocephalus, intracerebral calcification
Diagnosis, prevention & treatment

- Isolation of parasite impractical
- Primarily diagnosed by serology (antibody detection)
- Serological survey shows worldwide distribution including Thailand
- Prevention by
  - Properly cook meat,
  - Proper handling of cat’s faeces
- Treatment: pyrimethamine and sulfadiazine, plus folinic acid.
Sarcocystis spp.

- Affect intestine
- Human as definitive host
  - *S. hominis*: bovine = IH
  - *S. suihominis*: porcine = IH
  - Intestinal sarcocystosis
  - Usually no signs and symptoms, a few cases of segmental eosinophilic enteritis
- Not opportunistic parasite

- Affect muscle
- Man as accidental host
  - *S. nesbitti* of snake (cobra)
  - Muscular sarcocystosis
  - Fever, and/or myalgia, arthralgia, headache, fatigue
  - Later myositis: pain and swelling. Eosinophilia, high CPK
**S. hominis and S. suihominis**

- Oocysts: thin-walled, sporulated when come out in faeces; “8”-like
- Sporocyst size:
  - 15 x 9 μm (S. hominis); 13 x 9 μm (S. suihominis)
- Sarcocysts with septa
  - Bradyzoites (banana shape)
Humans as definitive (final) hosts for Sarcocystis species.

Humans as aberrant intermediate hosts for Sarcocystis species.

Sporocysts are ingested in contaminated food or water

Sporocyst excreted

Sporozoites excyst

Schizonts develop in blood vessels

Merozoites invade muscle

Sarcocysts develop in skeletal and cardiac muscle

Definitive Host (reptiles?)

Presumed:
Snake eats intermediate host species infected with mature sarcocysts of Sarcocystis nesbitti

Human are Aberrant Intermediate Hosts

Diagnosis

• Intestinal sarcocystosis
  • Microscopic observation of oocysts or sporocysts in fecal smear
    • Wet fecal smear- sporulated oocysts
    • Acid fast stain- irregular staining (some stained, some don’t)

• Muscular sarcocystosis
  • Tissue biopsy, section and stained.
Cystoisospora belli

- Only in human and primate
- Asexual and sexual reproduction in epithelial cell of the small intestine
- Oocyst sporulation outside host: 1-5 days
- Acute infection: diarrhea, self-limited
- Immunodeficient person: severe diarrhea
- Diagnosis: unsporulated oocyst, 20-23 x 10-19 μm
- Treatment: trimethoprim and sulfamethoxazole

Fresh faecal smear

Acid fast stained smear
Cryptosporidium

- Parasite of mammals, birds, reptiles, fish, amphibians: rather host-nonspecific
- Human: mostly *C. parvum*, *C. hominis*
- Oocyst 5 µm in diameter, smallest of all human coccidian
  - 4 naked sporozoites

Unstained faecal smear (marvistavet.com)

Acid-fast stained smear (getfor4t.com)
• Life cycle similar to *Cystoisospora belli* (development occurs in GI epithelium) except:
  • Organism is intracellular, extracytoplasmic
  • Sporulation in host cells-
    • thick-wall oocysts
    • thin-wall oocysts (*autoinfective*)

• **PP** app. 2 days, **IP** app. 7-10 days

Electron micrograph (phoenixwaterfilter.com.au)
• Emerging infectious disease
• Impaired intestinal absorption + enhanced secretion
• Watery diarrhea, abdominal cramp, fever
• In immunocompetent persons, self-limited in 2 wk.
• In immunocompromised persons, severe diarrhea and malabsorption syndrome
• An important opportunist in AIDS patients

• 4 Clinical patterns:
  • < 4 stool/day
  • diarrhea < 2 mo.
  • Diarrhea > 2 mo.
  • Fulminant infection, 2L watery stool daily (CD4 < 50/microliter)

• Extraintestinal dissemination can occur, most common= biliary tract
• Infection worldwide including Thailand
  • Account for 5% of patient diarrhea
• Contaminated drinking water, food, direct contact
  • Clam
  • Outbreak involving 403,000 persons in Milwaukee associated with drinking water
• No effective, specific chemotherapy
• Diagnosis by stool exam for oocysts
Cyclospora cayetanensis

• Man is the only host
• Infect the small intestine, similar life cycle with C. belli → diarrhea
  • Unsporulated when come out with faeces
  • Sporulation requires 7-15 days in external environment
  • 2 sporocysts, each with 2 sporozoites
• IP app. 7 days
• Diarrhea (5-15 times/day)
• Self-limited (19-57 days), recurrent,
• More severe in AIDS patients
• Traveler's diarrhea
  • Implicated in Europeans returning from Asian/South American countries
  • Indonesia, Nepal, Thailand, Guatemala, Mexico
• Imported vegetables, salad & fruits = most frequent source of infection
  • Oocysts survive a week at 4 C
Waterborne outbreak reported
Also many foodborne outbreaks

- Imported vegetables, salad & fruits = most frequent source of infection
- Oocysts survive a week at 4°C
• Diagnosis
  • Stool exam for oocysts
  • Acid fast stain - must differentiate from Cryptoporidium
    • Oocyst slightly bigger than Cryptosporidium oocyst, i.e., 8.6 μm
    • Staining not uniform: dark red, unstained
• Prevention & control: avoid exotic salad & vegetable or wash well
• Treatment: Trimethoprim, sulfamethoxazole
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