


## Lecture 7: Emerging Parasitic Protozoa part 1 (Intro, Intestinal Protozoa (non-Apicomplexan), FLA, Microsporidia

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Emerging Infectious Diseases

## Readings-Protozoa pt. 1

- Ch. 8 (p. 163 [table 8.2])
- Ch. 11 (pp. 272-74, 275-76, 286)



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## Monsters Inside Me

- Primary amebic encephalitis (*Naegleria fowleri*, free living amoeba)
  - Background: <http://animal.discovery.com/invertebrates/monsters-inside-me/brain-eating-amoeba-naegleria/>
  - Video: <http://animal.discovery.com/videos/monsters-inside-me-the-brain-eating-amoeba.html>
- *Acanthamoeba keratitis* (*Acanthamoeba* spp., free living amoeba)
  - Background: <http://animal.discovery.com/invertebrates/monsters-inside-me/acanthamoeba-keratitis/>
  - Videos: <http://animal.discovery.com/videos/monsters-inside-me-acanthamoeba-keratitis.html>  
<http://animal.discovery.com/videos/monsters-inside-me-acanthamoeba-keratitis-parasite.html>

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## Learning objectives: Protozoans

- Describe basic characteristics of protozoa
- Know basic life cycle and developmental stages
- Required hosts
  - Transmission strategy
  - Infective and diagnostic stages
  - Unique character of reproduction
- Know the common characteristics of each group
  - Be able to contrast and compare
- Diseases, high-risk groups
- Diagnostic methods, treatment
- Know important parasite survival strategies

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## Protozoa (boring biology?)

- Unicellular Eukaryotes
- Motility
  - Cilia, Flagella, Amoeboid, Gliding
- Phylum Sarcomastigophora
  - Flagellates (*Trypanosoma*, *Leishmania*, *Giardia*, *Trichomonas*)
  - Amoebae (*Entamoeba* spp., *Naegleria*, *Acanthamoeba*)
- Phylum Ciliophora (*Balantidium*)
- Phylum Microsporidia (encompasses many genera)
- Phylum Apicomplexa-sporozoa (*Cyclospora*, *Cryptosporidium*, *Toxoplasma*, *Plasmodium*, *Babesia*)
- Usually range from 10–50µm

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## Taxonomic Overview

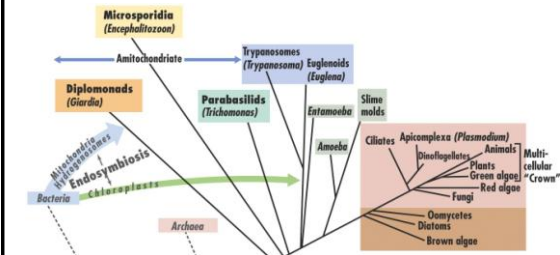


Figure 14-20a Brock Biology of Microorganisms 11e  
© 2006 Pearson Prentice Hall, Inc.

## Parasitic Protozoa



- Infect a variety of hosts
- Multiplication within hosts, enabling huge numbers in short periods
- 50,000 species of protozoa, of which a fifth are parasitic
- Life cycles
  - Usually less complex than helminths
  - Many examples of direct and indirect
  - Cyst form offers protection against harsh conditions, allowing to survive extreme temperatures or harmful chemicals or lack of food, water, or oxygen



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Table 77-1. Classification of Parasitic Protozoa and Associated Diseases

Phylum	Subphylum	Representative Genera	Major Diseases Produced in Human Beings	Chapter
Sarcostigmaphora (with flagella, pseudopodia, or both)	Mastigophora (flagella)	Leishmania	Visceral, cutaneous, and mucocutaneous infection	82
		Trypanosoma	Sleeping sickness, Chagas' disease	
	Sarcodina (pseudopodia)	Giardia	Diarrhea	80
		Trichomonas	Vaginitis	
		Entamoeba	Dysentery, liver abscess	79
Apicomplexa (apical complex)	Dientamoeba	Colitis		
		Naegleria and Acanthamoeba	Central nervous system and corneal ulcers	81
	Plasmodium	Malaria		83
		Babesia	Diarthra	80
Microspora	Sporozoa	Sarcocystis	Diarrhea	
		Cryptosporidium	Diarrhea	
		Toxoplasma	Toxoplasmosis	84
		Enteroocytozoon	Diarrhea	—
Ciliophora (with cilia)	Ciliates	Balantidium	Dysentery	80
		Unclassified	Pneumocystis	Pneumonia

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TABLE 11.2 Major Protozoan Diseases

Organism	Classification	Disease	Transmission	Principal Site(s)
<b>Foodborne and waterborne</b>				
Giardia	Mastigophora	Giardiasis	Water, direct contact	Intestinal tract
Entamoeba	Sarcodina	Amebiasis	Water, food, direct contact	Intestinal tract
Cryptosporidium	Cryptosporidiosis	Sporozoa	Water	Intestinal tract
Toxoplasma	Sporozoa	Toxoplasmosis	Food; contact with cat feces resulting in fecal-oral transmission	Brain, heart, lungs; possible transfer to fetus transmission
<b>Arthropodborne</b>				
Trypanosoma brucei	Mastigophora	African sleeping sickness	Tsetse fly	Blood
Trypanosoma cruzi	Mastigophora	Chagas disease (South American trypanosomiasis)	Kissing bug	Heart
Leishmania	Mastigophora	Leishmaniasis	Sand fly	Liver, spleen, mucocutaneous membranes, skin
Plasmodium	Sporozoa	Malaria	Mosquito	Blood
Babesia	Sporozoa	Babesiosis	Tick	Blood
<b>Sexually transmitted</b>				
Trichomonas	Mastigophora	Trichomoniasis	Sexual contact	Urogenital tract

Another nice review slide



## On the Menu: Lecture 7



### Intestinal Protozoa

- Amoeboae
  - *Entamoeba histolytica*
- Flagellates
  - *Giardia lamblia*
  - *Trichomonas vaginalis*
- Ciliates
  - *Balantidium coli*

### Other Important Protozoa

- Free-living amoebae
- Microsporidia

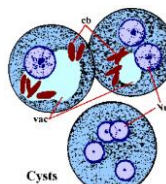


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## Entamoeba histolytica

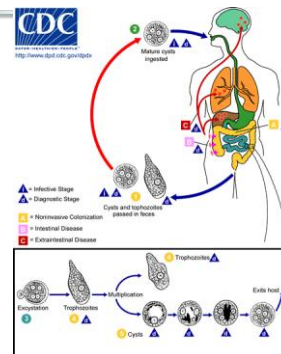
- Cosmopolitan distribution
- Infects 500 million people worldwide- causes Amebiasis
- 100,000 deaths per year have been attributed to complications of amebiasis, notably amoebic liver abscess
  - **Second in terms of deaths from parasitic protozoa**
- More prevalent and more severe in tropical/subtropical locations
- Risk groups
  - Crowded conditions: orphanages, prisons, mental institutions may exacerbate transmission of disease.
- 1-5% infected in U.S.
- Highly pathogenic
- **Humans=definitive host**
- **Fecal-oral transmission**



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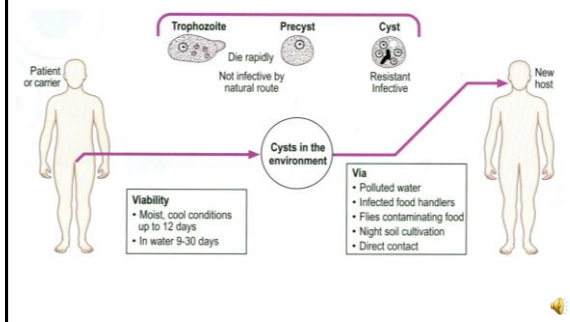
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## E. histolytica Life Cycle



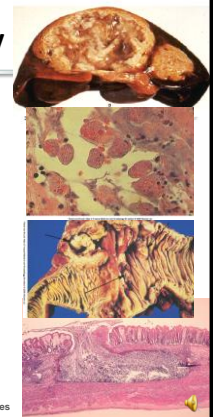
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## trophozoites and cysts



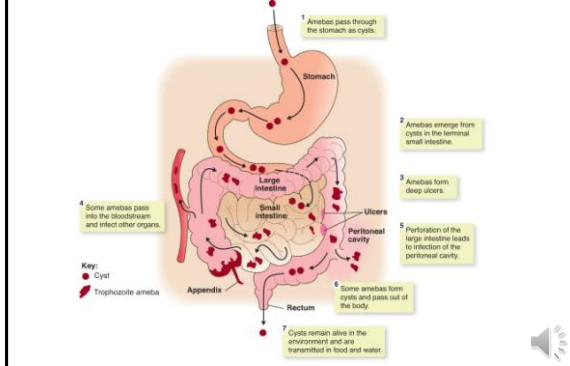
## Symptoms and Pathology

- Asymptomatic infection ("luminal amebiasis")
- Invasive intestinal amebiasis (**dysentery**, colitis, appendicitis, toxic megacolon)
- Invasive extraintestinal amebiasis (liver abscess, peritonitis, pleuropulmonary abscess, cutaneous and genital amebic lesions).
- Death and illness due to dysentery and liver abscess.
- Typical flask-shaped lesions in the large intestines



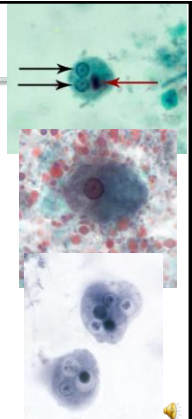
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## Amebiasis caused by *Entamoeba histolytica*



## Diagnosis

- Microscopic identification of cysts and trophozoites in the stool
  - Characteristics: bulls-eye nucleus, ingested red blood cells, chromatin bar
- Differentiation from other amoebae based on morphologic characteristics of the cysts and trophozoites.
  - *Entamoeba dispar* (non-pathogenic) vs. *E. histolytica*, based on isoenzymatic, immunologic, or molecular analysis.



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## Treatment

- Asymptomatic- only carry cysts
  - Metronidazole (Flagyl)
  - Iodoquinol
  - Diloxanide furoate (Furamide) if passing cysts (not in U.S.)
  - Paromomycin
- Symptomatic
  - Acute amebic dysentery
    - Emetine HCL
  - Liver abscess
    - Flagyl
    - Tinidazole or Omidazole (not in US)
      - Followed by treatment with iodoquinol, paromomycin, or diloxanide furoate



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## Prevention

- Safety of drinking water supplies
  - Cysts are fairly resistant to chlorination of drinking water
- Environmentally stable cysts
  - Heat water above 50°F
  - Freezing kills cysts
- Traveler precautions



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## Outbreaks

- World's Fair, Chicago (1933)
  - >1400 cases, 100 deaths
- Los Angeles, CA. (1983)
  - 38 patients over the course of 3 months were diagnosed, in comparison to a previous frequency of about 1 case per month.
- Tbilisi, republic of Georgia (1998)
  - A case-control study identified 177 cases, but outbreak was widespread may have affected 84,000–225,000 people.
- Emerging in Japan
  - Male homosexuals and mentally handicapped persons in institutions.
    - 500–600 cases of amebiasis reported annually, with 3-4 deaths



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## Giardia lamblia

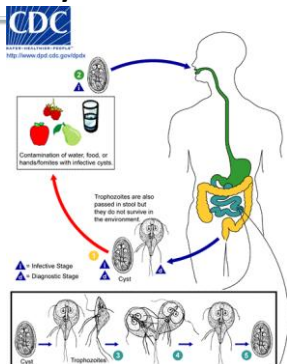
- Obligate parasite that infects numerous mammalian hosts
- Fecal-oral transmission through food and water
- Distributed worldwide, more prevalent in warm climates, and in children.
  - Up to 2 million cases in U.S. per year
  - Prevalence 3-7% in developed countries
  - Average prevalence of 20% in undeveloped countries
- The most frequent cause of non-bacterial diarrhea in U.S.**
- Risk groups in the US: travelers, children in day care, homosexual men

Flagellated with ventral sucker disk (for attachment)



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## Giardia Life Cycle



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## Giardiasis

- Acute disease develops after an incubation period of 1-14 days (average of 7 days) and usually lasts 1-3 weeks.
- Symptoms
  - Diarrhea**, abdominal pain, bloating, nausea, vomiting, **steatorrhea (fatty diarrhea)**.
  - In chronic giardiasis, the symptoms are recurrent and malabsorption and debilitation may occur.
- Suction force may damage microvilli.
- Large number of parasites may interfere mechanically with digestion.
- Symptoms may result from inflammation of the mucosal cells of the small intestine.
- Asymptomatic carriage
- Antigenic Switching** occurs during differentiation to cyst stage when a parasite is transmitted from one host to another.
  - Enhances the probability of parasite being transmitted to reservoir animals that are partially immune to other variants.



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## Diagnosis and Treatment

- Identification of cysts or trophozoites (monkey-face morphology) in the feces
- Samples of duodenal fluid or duodenal biopsy may demonstrate trophozoites.
- Antigen detection tests by enzyme immunoassays, and detection of parasites by immunofluorescence.
- Treatment:
  - Metronidazole**,
  - Tinidazole, Nitazoxanide in children.



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## Prevention

- Proper hygiene and disposal of waste
- Avoid drinking water from sources associated with outbreaks
- Avoid swallowing water while swimming in public pools, water parks
- Avoid livestock and exotic pets, zoonotic transmission
- In day care centers: wash hands and proper disposing of diapers
- Hikers and backpackers: boil, filter, chemically treat water
- Water filtration (moderate Chlorine resistance)

<http://www.cdc.gov/healthywater/pdf/swimming/resources/giardia-factsheet.pdf>



## Major Outbreaks

- Europe
  - Sweden 1986- >1400 cases
  - Norway 1994- >1300 cases
- U.S.
  - Colorado (Vail-1978): 5,000 cases
  - Rome, N.Y. (1974-1975): 4800-5300 cases
  - Bradford, PA. (1979): 3500 cases
  - Berlin, N.H. (1977): 7000 cases
  - Florida (1996): 77 cases



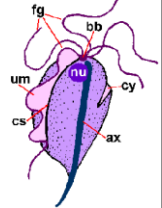
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## Trichomonas vaginalis

- Causes the most prevalent non-viral sexually transmitted disease worldwide
- Only known host is humans
- Worldwide prevalence, but higher prevalence among persons with multiple sexual partners or other venereal diseases
- No cyst stage; sexual transmission of trophozoites during intercourse
- Found in vagina and urethra of women and prostate, seminal vesicles, urethra of men
- Other non-pathogenic species: *T. hominis*, *T. tenax*
- Over 180 million infected each year globally, up to 8 million in U.S.
  - *Trichomonas* is the most common parasitic infection in the U.S., accounting for an estimated 7.4 million cases per year.

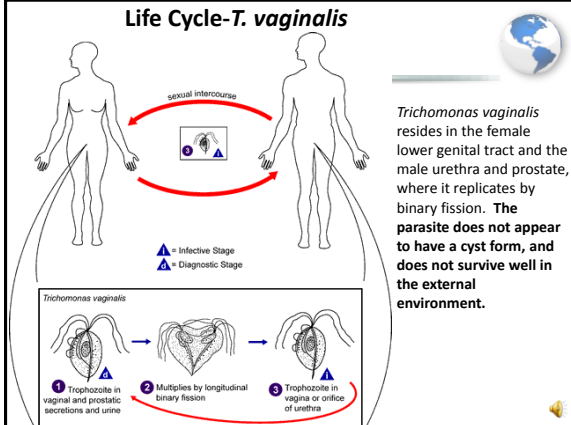
Characteristic multiple flagella at top and axostyle on side



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## Life Cycle-*T. vaginalis*



## Trichomoniasis: Clinical Features

- Women
  - More persistent infection
  - Vaginitis with a pus-like discharge (leukorrhea) is the prominent symptom, and can be accompanied by vulvar and cervical lesions, abdominal pain, dysuria and dyspareunia.
  - Predisposes to HIV infection- erosion of vaginal wall-blood into vagina
  - Pelvic Inflammatory Disease- damage the fallopian tubes and tissues in and near the uterus and ovaries.
  - Increased risk of cervical cancer, association with preterm birth and premature rupture of membrane and low birth weight infants
- Males usually **asymptomatic**; occasionally infects prostate and seminal vesicles.
  - Increased HIV transmission, infectivity
  - Common cause of nongonococcal urethritis
  - Male infertility- decrease sperm motility and viability



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## Trichomoniasis: Diagnosis/Rx

- Clinical presentation: discharge, strawberry cervix
  - In men, anterior urethral or prostatic secretions should be examined.
  - Microscopic examination of vaginal and urethral secretions can establish the diagnosis by detecting actively motile organisms.
  - Direct immunofluorescent antibody staining is more sensitive than wet mounts, but technically more complex.
  - PCR assays
- Treatment**
- Metronidazole and tinidazole; therapy is usually highly successful.
  - Strains of *Trichomonas vaginalis* resistant to both drugs have been reported.



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## Prevention

- Abstain from sexual contact, or to be in a long-term mutually monogamous relationship with a partner who has been tested and is known to be uninfected.
- Condom use for as long as both partners are infected
- Any genital symptom such as discharge or burning during urination or an unusual sore or rash=consult a health care provider immediately.
- Possible transmission via contaminated towels, washcloths, clothing



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## Comparing, *Giardia*, *Trichomonas* and *E. Histolytica*

	<i>G. lamblia</i>	<i>E. histolytica</i>	<i>T. vaginalis</i>
<b>Morphology</b>	Flagellate	Ameba	Flagellate/Ameba
<b>Life forms</b>	Trophozoite Resistant Cyst	Trophozoite Resistant Cyst	Trophozoite only No Cyst form
<b>Host</b>	Many mammals including humans	Humans Only	Humans Only
<b>Transmission</b>	Ingestion of Cyst	Ingestion of Cyst	Sexual Intercourse
<b>Disease Manifestations</b>	Diarrhea/ Dysentery	Diarrhea/ Dysentery	Vaginitis

Review, anyone?



## *Balantidium coli*



- **Largest protozoan and only ciliate infecting humans**
  - Trophozoites: 50x35 µm and 100x70 µm, Cysts: 50-70 µm
- Tissue invasive in **large intestines**: causes dysentery
- Extraintestinal spread (e.g. lungs, liver)
- Pigs implicated as reservoir host
  - Other potential animal reservoirs include rodents and nonhuman primates.
- Worldwide distribution
- Periodic outbreaks in institutionalized populations

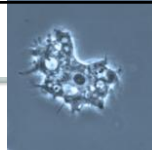


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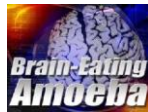
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## Free-living amoebae

- Species of *Acanthamoeba*, *Balamuthia*, *Naegleria* and *Sappinia* are important causes of disease in humans and animals.
  - 9 species of *Acanthamoeba* implicated in human disease.
- *Naegleria fowleri* and *Acanthamoeba* spp. commonly found in lakes, swimming pools, tap water, soil, and heating and air conditioning units.
- *Balamuthia mandrillaris*, is morphologically similar to *Acanthamoeba* and causes human disease.
- While infrequent, infections occur worldwide.
  - Can be isolated from all types of fresh water and soil habitats



Attack of the.....



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## *Naegleria fowleri*



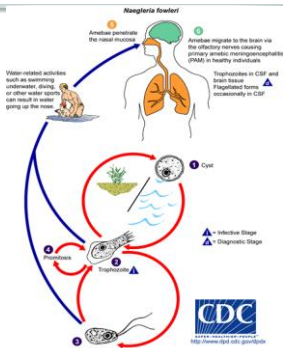
- Usually found in warm bodies of water such as ponds, irrigation ditches, lakes, coastal waters, and hot springs, well water
  - Water temp. between 77–95°F
- Can cause **primary amebic meningoencephalitis**
- Other species are non-pathogenic to humans



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## *Naegleria fowleri* life cycle



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## *Naegleria fowleri* in the USA



- In U.S., has caused infections in 15 southern tier states
  - 121 deaths in the U.S. from 1937 through 2007.
  - From 1998 to 2007, 33 infections were reported in the U.S., all but one died
  - 6 documented deaths in 2007, all in warmer regions (Arizona, Texas, Florida)
- Florida
  - Prior to 2008, primary amebic meningoencephalitis was not a reportable disease in Florida.
    - 30 cases have been documented from 1962 through 2007. Of the 30 cases, 19 were from Central Florida, (3 in Orange County in 2007)
      - Other counties: Baker, Brevard, Broward, Citrus, Lee, Miami-Dade, Orange, Pasco, Pinellas, Polk, Putnam, Seminole and 3 unknown counties. All cases resulted in death.



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3 deaths in Summer 2007 around Orlando area

**Deadly amoeba lurks in Florida lakes**

SEARCH RESULTS

- 1. This deadly amoeba lurks in Florida lakes and is not a new discovery. It has been known to cause a rare but deadly form of brain disease in people with weakened immune systems.
- 2. The amoeba is called *Naegleria fowleri* and is found in warm freshwater lakes, rivers, and hot springs.
- 3. The amoeba enters the nasal passages, penetrates the nasopharyngeal mucosa, and migrates to the olfactory nerves, eventually invading the brain through the cribriform plate.
- 4. The initial symptoms of PAM start 1-14 days after infection.
- 5. Headache, fever, nausea, vomiting, and stiff neck.
- 6. As the amoeba causes more extensive destruction of brain tissue this leads to confusion, lack of attention to people and surroundings, loss of balance and bodily control, seizures, and hallucinations.
- 7. Progresses rapidly (<10 days) and frequently to coma and death.

**Most Popular**

1. Botox for Alzheimer's Disease
2. ...
3. ...
4. ...
5. ...
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## Primary Amebic Meningoencephalitis

- Acute and usually lethal, central nervous system (CNS) disease
- The amoeba enters the nasal passages, penetrates the nasopharyngeal mucosa, and migrates to the olfactory nerves, eventually invading the brain through the cribriform plate.
- The initial symptoms of PAM start 1-14 days after infection.
  - Headache, fever, nausea, vomiting, and stiff neck.
- As the amoeba causes more extensive destruction of brain tissue this leads to confusion, lack of attention to people and surroundings, loss of balance and bodily control, seizures, and hallucinations.
- Progresses rapidly (<10 days) and frequently to coma and death.

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## Diagnosis and Treatment

- In *Naegleria* infections, the diagnosis can be made by microscopic examination of cerebrospinal fluid (CSF).
- A wet mount may detect motile trophozoites, and a Giemsa-stained smear will show trophozoites with typical morphology.
- Often diagnosed post-mortem
- Can be found by MRI and treated with antibiotics if found early enough
- Amphotericin B is effective against *N. fowleri* *in vitro*
- After progression to PAM, less than 1% survival

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## Naegleria Prevention

- Avoid swimming or jumping into bodies of warm freshwater, hot springs and thermally polluted water such as water around power plants.
  - Water above 80°F- use caution
- Avoid swimming or jumping into freshwater during periods of high temperature and low water volume.
- Hold the nose shut or use nose clips when jumping or diving into bodies of warm fresh water such as lakes, rivers or hot springs.

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## Acanthamoeba spp., Balamuthia

- Both are opportunistic protozoan pathogen that rarely causes disease in humans.
- *Acanthamoeba* spp.
  - Approximately 400 cases have been reported worldwide with a survival rate of 2-3%.
  - No flagella and can't tolerate water as hot as *Naegleria* can
  - Usually skin infections, **but serious disease in immunocompromised**
- *Balamuthia mandrillaris*
  - Approximately 100 published and unpublished cases of *Balamuthia* amebic encephalitis (BAE) have been reported; most were fatal.
  - Extremely rare, mostly in immunocompromised

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## Life cycles

**Acanthamoeba spp.**

1. Acanthamoeba egg
2. Through nasal passage
3. Through nasal passage, enters body through body temperature
4. Penetrates olfactory mucosa, enters bloodstream
5. Penetrates olfactory mucosa, enters bloodstream
6. Penetrates olfactory mucosa, enters bloodstream
7. Penetrates olfactory mucosa, enters bloodstream
8. Penetrates olfactory mucosa, enters bloodstream
9. Penetrates olfactory mucosa, enters bloodstream
10. Penetrates olfactory mucosa, enters bloodstream

**Balamuthia mandrillaris**

1. Balamuthia mandrillaris
2. Through nasal passage
3. Through nasal passage, enters body through body temperature
4. Penetrates olfactory mucosa, enters bloodstream
5. Penetrates olfactory mucosa, enters bloodstream
6. Penetrates olfactory mucosa, enters bloodstream
7. Penetrates olfactory mucosa, enters bloodstream
8. Penetrates olfactory mucosa, enters bloodstream
9. Penetrates olfactory mucosa, enters bloodstream
10. Penetrates olfactory mucosa, enters bloodstream

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## Diseases

- Both can cause granulomatous amebic encephalitis (GAE) in individuals with compromised immune systems.
- Acanthamoeba* crosses the blood brain barrier and invades connective tissue, induction of pro-inflammatory responses leads to neuronal damage which can be fatal within days.
  - Subacute symptoms including altered mental status, headaches, fever, neck stiffness, seizures, other neuropathies leading to coma and death
  - Also, granulomatous skin lesions and keratitis, corneal ulcers following corneal trauma or contaminated contact lens use.
- Balamuthia*-induced GAE can cause focal paralysis, seizures, and brainstem symptoms such as facial paralysis, difficulty swallowing, and double vision.
  - Also causes a variety of non-neurological symptoms, and often causes skin lesions, through which the amoeba may enter the bloodstream and migrate to the brain.



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## Diagnosis and Tx

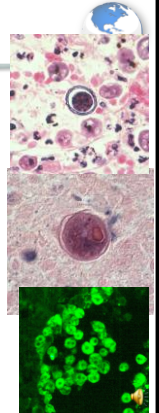
- In *Acanthamoeba* infections, the dx from microscopic examination of stained smears of biopsy specimens (brain tissue, skin, cornea) or of corneal scrapings
- Confocal microscopy or cultivation of the causal organism, and its identification by direct immunofluorescent antibody, may also prove useful.
- Post-mortem biopsy reveals severe oedema and hemorrhagic necrosis.

### Treatment

- The misdiagnosis of bacterial encephalitis often leads to erroneous treatment that is ineffective.
- In the case that *Acanthamoeba* is diagnosed correctly, amphotericin-B, rifampin, trimethoprim-sulfamethoxazole, ketoconazole, fluconazole, sulfadiazine, albendazole are only tentatively successful.



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## Prevention

- Encephalitis diseases: similar to *Naegleria*
- IC careful in environment-soil, water
- Acanthamoeba* keratitis
  - Wear and replace contact lenses according to the schedule prescribed by your eye care provider.
  - Remove contact lenses before any activity involving contact with water, including showering, using a hot tub, or swimming.
  - Wash hands with soap and water and dry before handling contact lenses.
- MRSA can infect and replicate inside of *Acanthamoeba polyphaga*; Since *A. polyphaga* can form cysts, cysts infected with MRSA can act as a mode of airborne dispersal for MRSA.
  - Pathogens that emerge from amoeba are more resistant to antibiotics and more virulent?



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**Acanthamoeba Keratitis — Multiple States, 2005–2007**

In May 2005, the Illinois Department of Public Health (IDPH) advised CDC about a possible outbreak of acanthamoebic keratitis (AK) in an ophthalmology clinic in Bloomington, Illinois. The University of Chicago (UIC) was contacted for possible assistance. On October 2005, IDPH updated CDC about the ongoing CDC investigation. At the time, CDC advised IDPH to continue to monitor for cases in Illinois and to continue to monitor for cases in other states. In January 2007, CDC advised IDPH to continue to monitor for cases in Illinois and to continue to monitor for cases in other states. On March 18, 2007, CDC advised IDPH to continue to monitor for cases in Illinois and to continue to monitor for cases in other states. CDC will continue to monitor for cases in Illinois and to continue to monitor for cases in other states.



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## Microsporidia

- One general phylum
- Obligate, spore-forming, intracellular parasites that invade vertebrates and invertebrates.
- Polar tube or polar filament found in the spore used to infiltrate host cells.
- More than 1,200 species belonging to 143 genera have been described as parasites infecting a wide range of vertebrate and invertebrate host.
- First human case was described in 1959 in a Japanese child.
- Transmission route is unclear
- Since 1985, microsporidia have been identified as a cause of opportunistic infections associated with persistent diarrhea and weight loss in persons with AIDS



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Microsporidian species	Clinical manifestation/location	Comments
<i>Brachiola algerae</i>	Keratoconjunctivitis, skin and deep muscle infection	
<i>Enterocytozoon bieneusi</i> *	Diarrhea, acalculous cholecystitis small and large intestine, gall bladder, bile duct, lung, nasal epithelium. Systemic disease	Global, in 6-30% of all AIDS patients with chronic diarrhea. Most common microsporidian in immunocompetent people.
<i>Encephalitozoon cuculici</i>	Brain, kidney, liver; Keratoconjunctivitis, infection of respiratory and genitourinary tract, disseminated infection	Global, Very rare, HIV+;
<i>Encephalitozoon hellem</i>	systemic spread to nose, eye, lung, kidney, etc. Keratoconjunctivitis, infection of respiratory and genitourinary tract, disseminated infection	may be transmitted via sputum, urine, nasal aerosol, known only from HIV+
<i>Encephalitozoon intestinalis</i> (syn. <i>Septata intestinalis</i> )	Infection of the GI tract causing diarrhea, and dissemination to ocular, genitourinary and respiratory tracts	Found in about 2% of all AIDS patients with chronic diarrhea
<i>Microsporidium</i> ( <i>M. ceylonensis</i> and <i>M. africanum</i> )	Infection of the cornea	Sri Lanka, Botswana
<i>Nosema</i> sp. ( <i>N. oculorum</i> ),	Ocular infection;	USA, HIV+
<i>Brachiola canorii</i>	striated and smooth muscle	Immunocompromised infant (athymic)
<i>Pleistophora</i> sp.	Muscular infection, striated muscle	USA, two cases immunocomp, HIV pos and neg
<i>Trachipleistophora anthropophthera</i>	Disseminated infection	
<i>Trachipleistophora hominis</i>	Muscular infection, stromal keratitis, (probably disseminated infection)	
<i>Vittiforma carseae</i> (syn. <i>Nosema carseum</i> )	Ocular infection, urinary tract infection	



## Wide range of disease



- Occurs mainly, but not exclusively, in severely immunocompromised patients with AIDS.
- **Chronic diarrhea and wasting are the most common symptoms of microsporidiosis**
- Disseminated infection is characterized by symptoms of cholecystitis (inflammation of the gallbladder), renal failure, respiratory infection, headache, nasal congestion, ocular pain and sinus involvement.
- Respiratory infection may cause cough, dyspnea (labored breathing) and wheezing.
- With ocular infection, symptoms range from foreign body sensations, eye pain, light sensitivity, redness, excessive tearing or blurred vision.
- Finally, infections of the brain or other nervous tissue cause seizures, headache and other symptoms depending the precise area of infection.



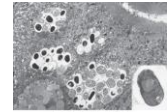
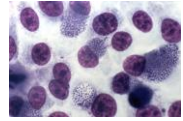
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## Diagnosis and Treatment



- DX: Microscopic ID-light and TEM, IFA, PCR
- Ocular microsporidiosis-oral albendazole plus topical fumagillin.
  - Corneal infections with *V. corneae* often do not respond to chemotherapy and may require keratoplasty.
- Oral fumagillin has been effective to treat *Enterocytozoon bienewisi* infections, but it has been associated with thrombocytopenia.
- Albendazole for gastroenteritis caused by *Encephalitozoon intestinalis* and to treat disseminated microsporidiosis (various species) and skin and deep muscle infection (*Brachyolva algerae*).



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## Prevention



- Transmission is still unclear, but possibly by inhalation, ingestion.
- Contaminated food and water sources?
- Highly resistant spores can survive outside host for up to several years
- Proper disinfection, sterilization in health care settings



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