INFECTIONS

DIAGNOSTIC CLUES

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Defenses

- The skin is the most difficult surface to penetrate.
- Free fatty acids in sebaceous glands act as detergents.
- Lactic acid in perspiration, acidic pH, and a relatively dry environment also hinder microbe survival.
- Mucous membranes may eliminate microbes through active propulsion (e.g., mucociliary escalator in the lung).
- Cationic peptides, lysozyme, lactoferrin, and secretory IgA are present and are anti-microbial.

Defenses

- Acidic pH in stomach, bladder, kidneys inactivate many microbes as do bile salts in the intestine.
- High urine flow also limits the establishment of infection.
- Normal flora can prevent pathogen colonization.

Normal flora

Site	Major organism	Minor organism
Skin	Staphylococcus epidermidis	Staphylococcus aureus, Corynebacterium spp., Pseudomonas aeruginosa, Candia spp.
Nose	Staphylococcus aureus	Staphylococcus epidermidis, Corynebacterium spp.
Mouth	Streptococcus viridans	
Gingiva	Bacteroides, Fusobacterium, Actinomycetes	
Dental plaque Throat	Streptococcus mutans Streptococcus viridans	Streptococcus pyogenes, Streptococcus pneumoniae, Neisseria meningitidis, Hemophilus influenzae

Normal flora

Site	Major organism	Minor organism
Colon	Escherichia coli, Baccilus fragilis	Enterococcus fecalis, Clostridium, Lactobacillus
Vagina	Lactobacillus	E. coli, Streptococcus agalactiae (Gp. B) are frequent colonizers
Urethra		Staphylococcus epidermidis, Corynebacterium spp., Escherichia coli are frequent colonizers

Vertical transmission of flora

Path	Pathogen	Disease
Transplacental	Treponema pallidum	Congenital syphilis
	Listeria monocytogenes	Neonatal sepsis and meningitis
	Toxoplasma gondii	Toxoplasmosis
	Cytomegalovirus	Congenital abnormalities
	Parvovirus B19	Hydrops fetalis
Breast milk	Staphylococcus aureus	Oral or skin infection
	Cytomegalovirus Human T-cell Leukemia Virus Human Immunodeficiency Virus	Asymptomatic infection Asymptomatic infection Asymptomatic infection

Vertical transmission of flora

Path	Pathogen	Disease
Birth Canal at time of birth	Streptococcus agalactiae (Gp. B)	Neonatal sepsis and meningitis
	Escherichia coli	Neonatal sepsis and meningitis
	Chlamydia trachomatis	Conjunctivitis or pneumonia
	Neiserria gonorrheae	Conjuncitivitis
	Candida albicans	Thrush
	Herpes Simplex II Virus	Skin, CNS, or disseminated infection
	Hepatitis B Virus Human Immunodeficiency Virus	Hepatitis B Asymptomatic infection

Presence of foreign bodies

Urinary bladder catheter	Escherichia coli
Intravenous catheter	Staphylococcus epidermidis, C.andida albicans
Prosthetic heart valve	Staphylococcus epidermidis, C.andida albicans
Prosthetic joints	Staphyloccus epidermidis
Vascular grafts	Staphyloccus epidermis, Staphylococcus aureus, Salmonella enterica

Immuno-compromised host

Low antibody	Pyogenic bacteria such as Staphylococcus aureus, Streptococcus pneumoniae
Low complement (C3b)	Pyogenic bacteria such as Staphylococcus aureus, Streptococcus pneumoniae
Low complement (C6,7,8,9)	Neiserria meningitidis
Low neutrophil number	Pyogenic bacteria such as Staphylococcus aureus, Streptococcus pneumoniae Pseudomonas aeruginosa
Impaired neutrophil function	Staphylococcus aureus, Aspergillus fumigatus
Low CD4 cells	Mycobacteria, Candida spp., Pneumocystis jirovecci, Cytomegalovirus
Splenectomy	Hemophilus influenzae, Streptococcus pneumoniae, Neisseria meningitidis

Opportunistic infection in the immuno-compromised host

CD4 <500	Kaposi's sarcoma Thrush (Candida albicans) Tuberculosis Herpes simplex virus infection Varicella-Zoster virus infection
CD4 <200	Pneumocystis jirovecci (carinii) pneumonia Toxoplasmosis Cryptococcosis Systemic fungal infection
CD4 <100	Cytomegalovirus infection Mycobacterium-avian complex (MAC) Aspergillosis CNS lymphoma (EBV associated) Progressive multifocal leukoencephalopathy

Viral illnesses

Portal of entry	Probable organisms
Respiratory Tract	Influenza virus, Rhinovirus, Respiratory syncytial virus, Epstein-Barr virus, Varicella-Zoser virus, Herpes virus 1, Cytomegalovirus, Measles virus, Mumps virus, Rubella virus, Hantavirus, Adenovirus
Gastrointestinal Tract	Hepatitis A virus, Poliovirus, rotavirus
Skin	Rabies virus, Yellow fever virus, Dengue virus, Human papilloma virus
Genital Tract	Human papilloma virus, Hepatitis B virus, Herpes virus 2, Human immunodeficiency virus
Blood	Hepatitis B, C, D viruses, Human T-cell lymphotropic virus, Human immunodeficiency virus, Cytomegalovirus

Protozoal infections

Location	Organism	Disease	Transmission
Intestine	Entamoeba histolytica Giardia Lamblia Cryptosporidium parvum Balantidium coli	Amebiasis Giardiasis Cryptosporidiosis Dysentery	Ingestion cysts Cysts oocysts cysts
Urogenital tract	Trichinella vaginalis	Trichinosis	Intercourse (trophozoite)
CNS	Acanthamoeba spp. Nagleria fowlerii	Meningitis Meningitis	Amoebae in pond water
Blood	Plasmodium spp. Babesiosis microti	Malaria Babesiosis	Sporozoite from: Anopheles mosquito Ixodes tick

Protozoal infections

Location	Organism	Disease	Transmission
Blood	Trypanosoma Cruzi Trypanosoma gambiense, rhodesiense	Chagas Sleeping sickness	trypo-mastigotes in bite of: Reduuvid bug Tsetse Fly
	Leishmania mexicana, braziliensis L. donovani	Leishmaniasis (cutaneous) (visceral)	Amastigotes in bite of Sand Fly
Tissue	Pneumocystis		Inhalation
	Toxoplasma	Toxoplasmosis	Ingestion of oocysts

Helminthic infections

Location	Organims	Transmission
Intestine	Enterobius (Pinworm)	Ingestion of eggs
	Trichuris (Whipworm)	Ingestion of eggs
	Ascaris	Ingestion of eggs
	Ancylostoma Necator (Hookworm)	Larval penetration of skin
	Strongyloides	Larval penetration of skin
	Trichinella	Larvae in meat
	Asinakis	Larvae in fish

Helminthic infections

Location	Organism	Transmission
Tissue	Wucheria (Filariasis)	Mosquito
	Onchocerca	Black fly
	Loa	Deer fly
	Dracunculus (Guinea worm)	Ingestion of copepods
	Toxocara (Visceral larva migrans)	Ingestion of eggs
	Ancylostoma larvae (Cutaneous larva migrans)	Penetration of skin

Helminthic infections

Location	Organism	Transmission (Ingestion)
Tissue	Schistosoma mansonii	Cercaraie penetrate skin
	Schistosoma japonicum	Cercaraie penetrate skin
	Schistosoma hematobium	Cercaraie penetrate skin
	Clonorchis sinensis	raw fish
	Paragominus westermanii	raw crab

Causes of relapsing fevers

- Malaria
- Ehrlichiosis
- Babesiosis
- Influenza
- Typhoid fever
- Tularemia
- Brucellosis
- Colorado tick fever
- Rickettsioses
- Dengue
- Leptospirosis
- Rat-bite fever
- Meningococcemia
- Viral hepatitis

Skin infections

- Tinea lesions as well as Sporotrichum schenkii cause superficial infections.
- Impetigo (and cellulitis) is likely due to β-hemolytic Streptococci or due to Staphylococci or both. Toxic shock syndrome may follow.
- Immunocompromised patients may have cellulitis as a result of a gram negative bacillary infection, usually a local wound infection.

Skin infections

- MRSA must always be considered in any skin infection (present in over half of infections).
- Clindamycin or beta-lactam with trimethoprim-sulfisoxazole as antibiotic choices.
- Presence of ERM gene may transfer erythromycin resistance to clindamycin.

Skin infections

- Gram stain of wound may be diagnostic.
- Little advantage to routine culture.
- Fungal elements identified in a KOH preparation of nail scrapings is sufficient to institute treatment for onchomycosis.
- False negative rate 20%.
- Little advantage to fungal culture in dermatophytic infections.
- Always treat tinea pedis in a patient with cellulitis or erysipelas.
- Viral exanthems are caused by Measles, Rubella, Varicella-Zoster, Enterovirus, Human herpes 6, and Parvovirus B19.

Causes of conjunctivitis and keratitis

- Bilateral conjunctivitis is usually a manifestation of an allergic or autoimmune disorder.
- Unilateral conjunctivitis is a result of Rhinitis or Adenovirus, Hemophilus influenzae, Staphylococcus aureus, Neisseria gonorrheae, Chalmydia trachomatis infection.
- Conjuncitivitis of rapid onset with copious purulent exudate likely Neisseria gonorrheae.
- Keratitis is a result of Herpes simplex virus 1 infection.
- Varicella zoster virus and the free living amoeba, Acanthamoeba, may also cause keratitis.

Causes of rhinitis and pharyngitis

- Rhinitis is almost always of viral origin, principally Rhinovirus and Adenovirus.
- Parainfluenza virus and Coronavirus also cause rhinitis in children.
- Pharyngitis, tonsilitis is almost always of viral origin, principally Epstein-Barr virus, Adenovirus, Coxsackie A and B, Influenza virus, and Parainfluenza virus.

Causes of rhinitis and pharyngitis

- Bacterial pharyngitis is usually a pyogenic Strep. infection.
- Always consider the possibility of N. gonorrheae.
- Corynebacterium diphtheriae is unusual in a vaccinated population.
- Mycoplasma pneumoniae may also cause pharyngitis.

Causes of pharyngitis

- In adults with sore throats, enlarged cervical nodes and pharyngeal exudates suggest high risk for Strep. throat.
- Enlarged cervical nodes, recent cough, and fever >101F compatible with moderate risk for Strep. throat.
- Adult prevalence, 10-15%; children, 25-35%.
- A peritonsillar or retropharyngeal abscess is usually a pyogenic Streptoccous infection.

Causes of pharyngitis and bronchitis

- Epiglottitis is usually the result of Hemophilus influenzae type b, though pyogenic Streptococci and Streptococcus pneumoniae are also causes.
- Laryngitis and croup are almost always of viral origin, principally Parainfluenza virus, Influenza virus, Respiratory syncytial virus, and Adenovirus.
- Laryngeo-tracheobronchitis as well as bronchitis are almost always of viral origin, and includes as well Rhinovirus as a cause.
- Bacterial organisms as likely causes are Hemophilus influenzae type b, Staphylococcus aureus, and Bordatella pertussis.

Serologic tests and cultures

- Immunologic testing for Group A β-hemolytic Streptococcus on a throat swab is not cost effective where the prevalence of disease is >70% (as in an acute care setting).
- Diagnose on clinical grounds and treat.
- Throat culture is to confirm diagnosis made on clinical grounds and for epidemiologic purposes.
- Monospot (heterophile) inferior to Viral Capsid Antigen determination for Epstein-Barr infection.
- In the immunocompromised patient, virus detection by PCR is preferred.

Causes of sinusitis and otitis media

- Otitis media occurs generally in those 6-36 months of age.
- 30% of cases are viral.
- 70% are caused by Strep. pnemoniae, H. influenzae, Moraxella catarrhalis.
- Chronic suppurative otitis media is likely due to Staph. aureus or Pseudomonas aeruginosa.
- These are the organisms that cause sinusitis as well.

Otitis media

- Acute otitis media if ear rubbing or ear pain, or parental suspicion of same is associated with a positive likelihood ratio (LR+) of 3.4 and LR-, 0.4.
- A distinctly red tympanic membrane (LR+ 8.4) or a cloudy membrane (LR+ 34); slightly impaired (LR+ 4.0) or distinctly impaired (LR+ 31) tympanic membrane mobility; retracted (LR+ 3.5) or bulging (LR+ 51) tympanic membrane suggest otitis media.
- The prevalence in a general pediatric office practice is 20%.

Sinusitis

- Sinusitis likely (LR+ 6.4) if maxillary toothache, purulent nasal secretion or colored nasal discharge, transillumination abnormal, and there is poor response to decongestants.
- Prevalence of sinusitis is 50% in this group.
- An abnormal sinus radiograph is confirmatory.

Serologic tests and cultures

- Rapid antigen tests for influenza are not cost effective.
- Treat symptomatic patients if known coronavirus or influenza outbreak.
- Viral testing for epidemiologic purposes only.
- Chest x-ray to exclude pneumonia is not cost effective if adventitial sounds are not present on chest examination.
- Routine sputum cultures on outpatients are not cost effective.
- If productive cough, culture sputum produced. Bacterial stains may be useful.

Causes of pneumonia and meningitis

- NEONATES (0-4 weeks of age)
- Group B Streptococcus and E. Coli are the principal causes of pneumonia.
- With Listeria monocytogenes, are the principal causes of meningitis

Causes of pneumonia and meningitis

- CHILDREN (4 weeks- 6 years of age)
- RSV, Mycoplasma, Chlamydia and Streptococcus pneumoniae are the principal causes of pneumonia.
- Streptococcus pneumoniae, Neisseria meningitidis, Hemophilus influenzae type B, and Enterovirus are the principal causes of meningitis.

Causes of pneumonia

- CHILDREN (>6 years of age) AND ADULTS
- Respiratory syncytial virus pneumonia is common in children.
- Mycoplasma species, Chlamydia species, and Streptoccocus pneumoniae are leading causes of pneumonia. Following trauma, consider resistant Staphylococcus aureus (MRSA).
- Hemophilus influenzae becomes a more important cause of pneumonia in adults >40 years of age, those with COPD, and those with alcohol use.

Pneumonia

- 5% prevalence of pneumonia in an outpatient setting.
- In a outpatient non-asthmatic adult population, fever (>100F), heart rate >100/minute, abnormalities in auscultation, and tachypnea (>25/min) are associated with a 50% probability of pneumonia.
- In children, the absence of fever, tachypnea, and abnormalities on auscultation excludes pneumonia. The presence of all these findings is associated with a 21% probability of pneumonia.
- The detection of pneumonia requires a chest x-ray.
- Acute onset with high fever is compatible with pyogenic bacteria.

Viral pneumonia

- Acute onset, high fever, non-productive cough.
- Reticulo-nodular pattern (interstitial) throughout lung fields. Flattened diaphragms. Hyperlucency at apices.
- Influenza (occurs from December to May in the Northern Hemisphere), Parainfluenza, Respiratory syncytical viruses.
- Pleural effusion common.
- Rapid influenza tests in patients with fever and cough combined with a history of acute onset have a high likelihood of being positive (LR+, 4.7; LR- 0.06).

Bacterial pneumonia

- Usually Streptococcus pneumoniae (60%). Half the patients may also have an effusion.
- Acute onset of fever and chills, productive cough (Klebsiella pneumoniae, 10%, has thick mucoid sputum). Elderly patients may not have fever.
- May have pleuritic pain. Escherichia coli, Hemophilus influenzae (10%), Staphyloccous aureus, anerobes commonly have associated effusions.
- Can extend into pleural cavity (empyema). Usually Escherichia coli or anerobes.
- Dullness to percussion diagnostic (positive likelihood ratio, LR+, 18.6; LR-, 0.04).

Bacterial pneumonia

- Consolidation of lobe usually due to Streptococcus pneumoniae.
- Right middle lobe pneumonia is usually due to Hemophilus influenzae. May be seen with aspiration (and later abscess formation), however. Anerobic organisms may be present.
- Dependent lung zones include posterior segment of the upper lobes and superior segments of lower lobes. Aspiration usually to right lobe.

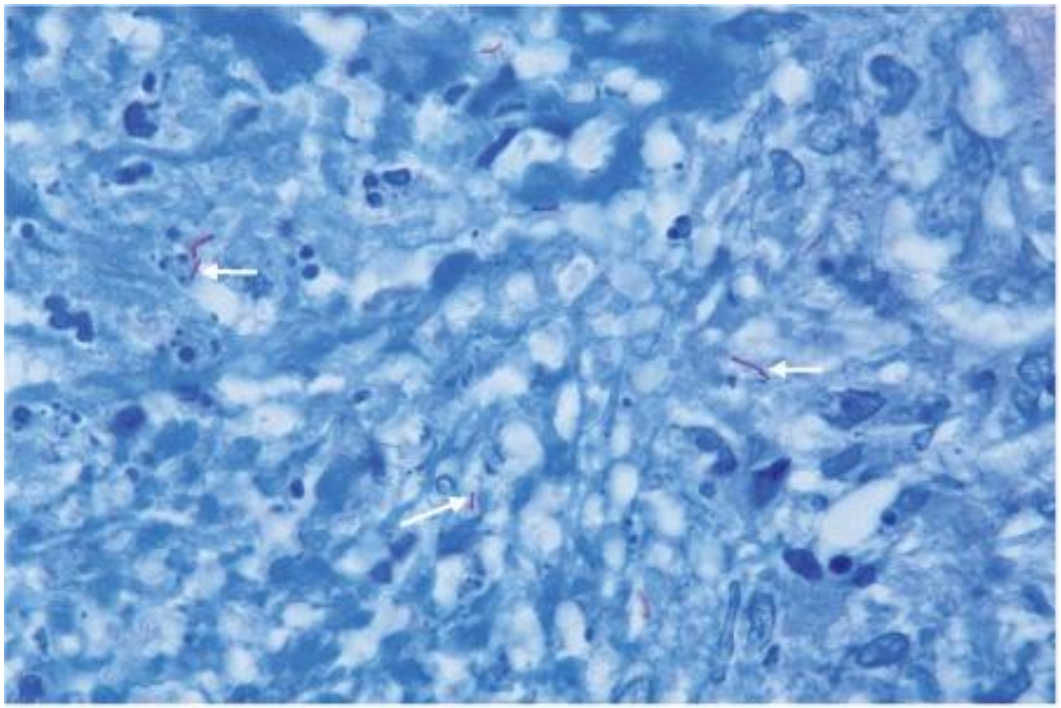
Bacterial pneumonia

- Upper lobe lesions are usually Mycobacterium tuberculosis. Consider aspiration pneumonia as well.
- Egophony, if present, increases likelihood of pneumonia (positive likelihood ratio, LR+, 8.6).
- Neither a normal chest examination nor a normal chest x-ray excludes the diagnosis of pneumonia.

Atypical pneumonia

- Insidious onset with sore throat and headache followed by low grade fever, non-productive cough, and dyspnea.
- Reticulo-nodular pattern (interstitial) throughout lung fields. Flattened diaphragms. Hyperlucency at apices.
- Mycoplasma pneumoniae, Chlamydia pneumoniae, Legionella pneumophilia.

Acid fast stain



Color plate 11 Accessed 02/01/2010

Acid fast positive bacteria of Mycobacterium tuberculosis (arrows).

Provider: CDC/ Dr. Edwin Ewing, Jr.

Causes of meningitis

- CHILDREN (>6 years of age) AND ADULTS
- The principal causes of meningitis are Neisseria meningitidis, Enterovirus, Streptococcus pneumoniae, and Herpes Simplex virus.
- Aseptic meningitis may be caused by Enterovirus, Poliovirus, Mumps, and the free living amoeba, Nagleria fowlerii.
- Chronic meningitis is seen with Mycobacterium tuberculosis, Treponema pallidum, Borrelia burgdorferi, Leptospira spiralis, Coccioides imitis, Taenia solium, and Trypanosoma brucei.

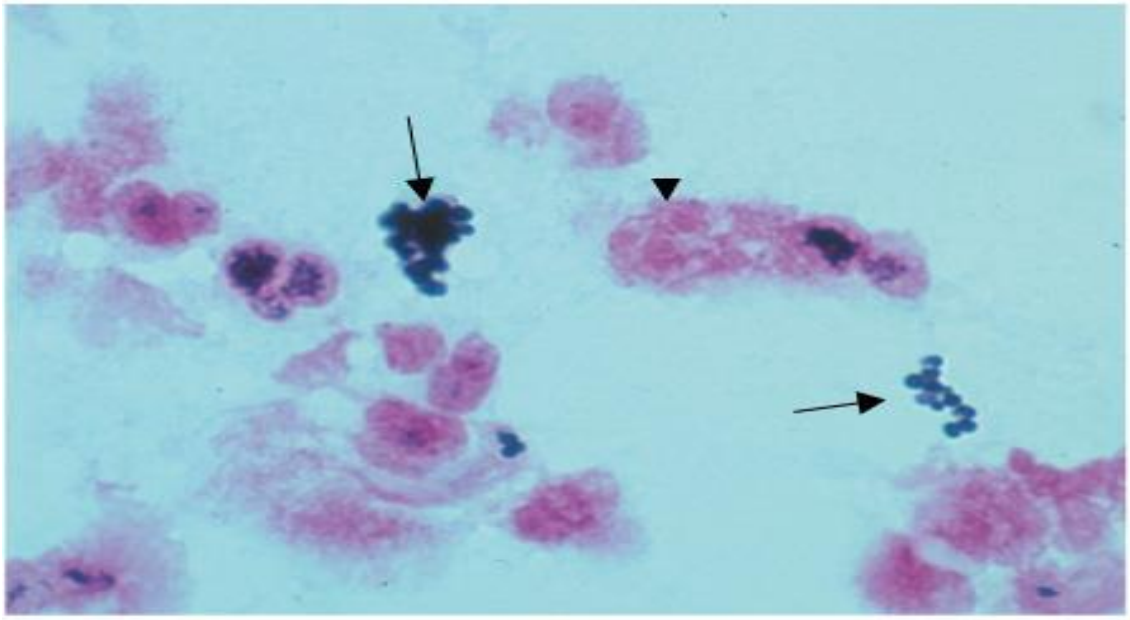
Meningitis

- In the immunocompromised patient, Cryptococcus, Mycobacterium tuberculosis, Toxoplasma, CMV must be considered. Cryptococcus and Toxoplasma develop over weeks. Toxoplasma associated with mass effects.
- Absence of fever, stiff neck, or altered mental state excludes meningitis in an adult.
- Lack of jolt accentuation of headache excludes meningitis (negative likelihood ratio, 0).
- Safe to perform LP without prior CT if no focal signs.

Serologic tests and cultures

- Gram stain of cytocentrifuged cerebrospinal fluid is rapid and diagnostic in cases of suspected meningitis.
- False positives common with bacterial antigen testing of cerebrospinal fluid.
- Pneumococcal antigen testing of urine may assist in establishing etiologic agent of infection.
- Culture mandatory of cerebrospinal fluid as well as of nasopharynx.

Gram stain



Source: Levinson W: *Review of Medical Microbiology and Immunology*, 10th Edition: http://www.accessmedicine.com

Gram positive, grape-like clusters of Staphylococcus spp.

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Myocardial infections

- Coxsackie A and B viruses most common cause of myocarditis.
- Myocarditis found in 85% of those with Trypanosoma cruzi infection (Chagas disease).
- Trichina spirella is the most commmon helminthic cause.
- Myocarditis is present in 5% of those with Lyme disease.
- Toxoplasma gondii, Cytomegalovirus and HIV are less common causes of myocarditis.

Heart valve infections

- Staphylococcus aureus is the principal cause of acute valvular infection.
- Streptococcus pneumoniae, Streptococcus pyogenes, and Pseudomonas aeruginosa are less likely causes.
- Subacute disease is generally caused by Streptococcus viridians, Enterococci, Staphylococcus epidermis, and HACEK.
- Occasionally Candida albicans is a cause.

Causes of diarrhea

- Acute diarrheal illness probably viral: Rotavirus, Norwalk virus, Astrovirus. Escherichia coli, Vibrios. No white cells present in stool.
- Red cells in fecal smear compatible with Shigella, enteropathogenic Escherishia coli, Salmonella species, Yersinia coli, and Entamoeba histolytica.
- Diarrhea in hospitalized patient likely Clostridium dificile. White cells present in stool.
- Cryptosporidia or cyclospora in immuno-compromised patients. No white cells in stool.
- Examination of three watery stools is adequate for ova and parasite examination.

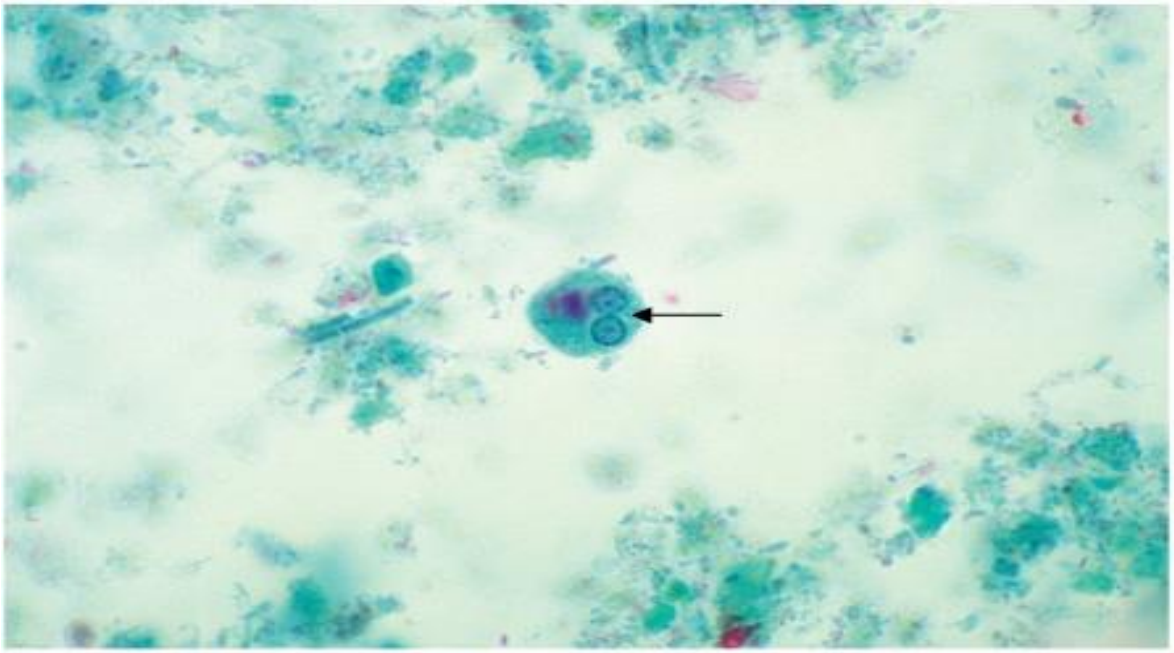
Causes of diarrhea

- Diarrhea persisting for many days suggests parasitic disease.
- If diarrhea in an infant at a child care center, is compatible with Giardia (stools smell foul). No white cells in stool.
- Giardia common with well water consumption as well.
- Food poisoning may be caused by Staphylococcus aureus (acute onset), Bacillus cereus, Clostridium botulinum, Campylobacter jejuni (associated with poultry).
- Helicobacter pylori is associated with duodenal ulcer. No diarrhea.

Diarrhea (immunocompromised)

- If AIDS patient with CD4 count >200 /uL, and on medications, diarrhea is likely medication related.
- If the CD4 count is <200 /uL, and the stool is of large volume, likely causes are Cryptosporidium, Microsporidia, Mycobacterium avium - intercellulare, or Giardia in decreasing order of frequency
- If the CD4 count is <200 /uL, and the stool is of small volume; if the stool contains leukocytes, consider Salmonella, Shigella, Clostridium dificile, CMV, and Entamoeba histolytica
- Kaposi's sarcoma and lymphoma are less likely causes

Stool



Entamoeba histolytica

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Parasites

- Leishamnia and Toxoplasma diagnosed on biopsy; all other protozoa, on smear
- Schistosoma mansonii and japonicum, are diagnosed by finding characteristic eggs in stool; Schistosoma hematobium, eggs in urine.
- Wucheria and Loa are diagnosed on smear. All other worms are generally diagnosed on biopsy or by demonstration of worm or worm parts in stool.

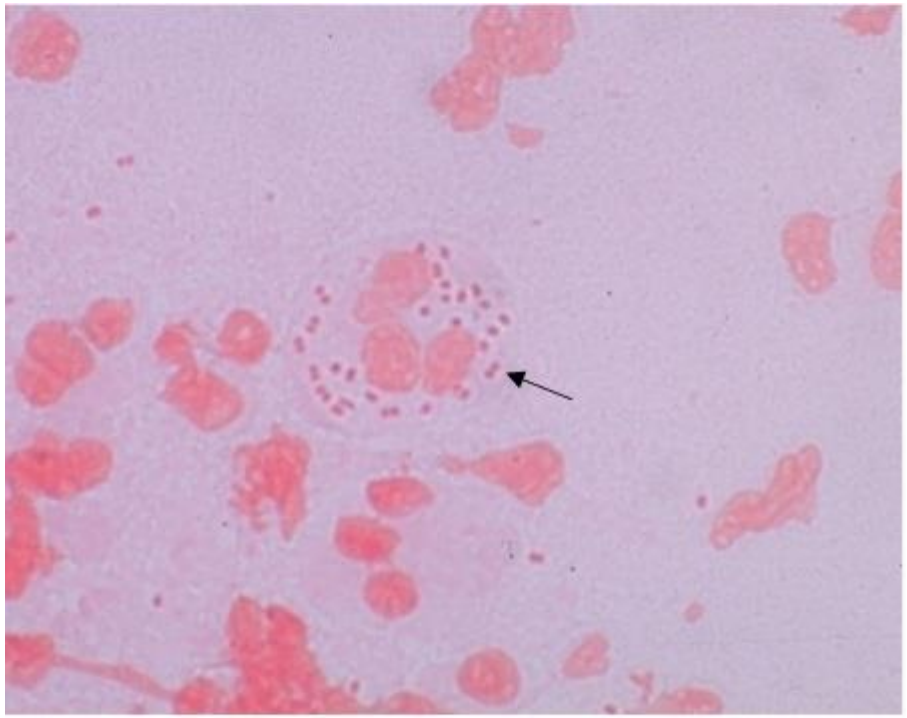
Causes of urogenital infections

- Cheesy vaginal discharge generally associated with Candida.
- Yellow vaginal discharge with fishy odor generally associated with Gardenerella.
- Frothy vaginal discharge generally associated with Trichomonas.
- Urethritis is caused by Mycoplasma (ureaplasma) species, Chlamydia trachomatis, and Neisseria gonorrheae.
- Warts represent Human papilloma virus.
- Urinary tract infection generally Escherichia coli, Enterobacteraciae species, or coagulase negative Staphylococcus.

Causes of urogenital infections

- Acute epidydimitis in those under 35 years of age is usually Neisseria gonorrheae and Chlamydia trachomatis.
- Acute epidydimitis in those over 35 years of age is usually Escherischia coli or Pseudomonas aeruginosa.
- Chronic epidydimitis is usually Mycobacterium tuberculosis.
- Painful chancre is likely Herpes simplex. Hemophilus ducrei and Chlamydia (lymphogranuloma venereum) are also causes of painful genital lesions. Syphilitic lesions are not painful.

Gram stain



Source: Levinson W: *Review of Medical Microbiology and Immunology*, 10th Edition: http://www.accessmedicine.com

Color plate 4 Accessed 02/01/2010

Gram negative, intracellular diplococci of Neiserria gonorrheae

Tzanck smear (Herpes simplex)

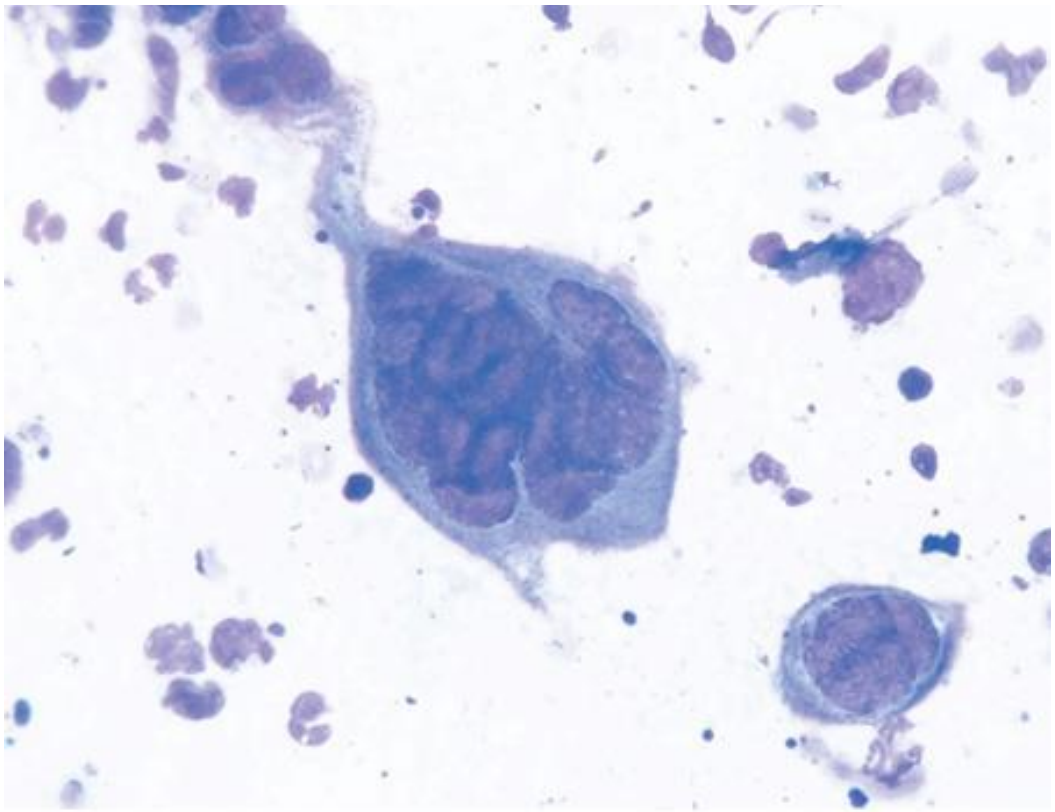


Fig. 27-27 Accessed 02/01/2010

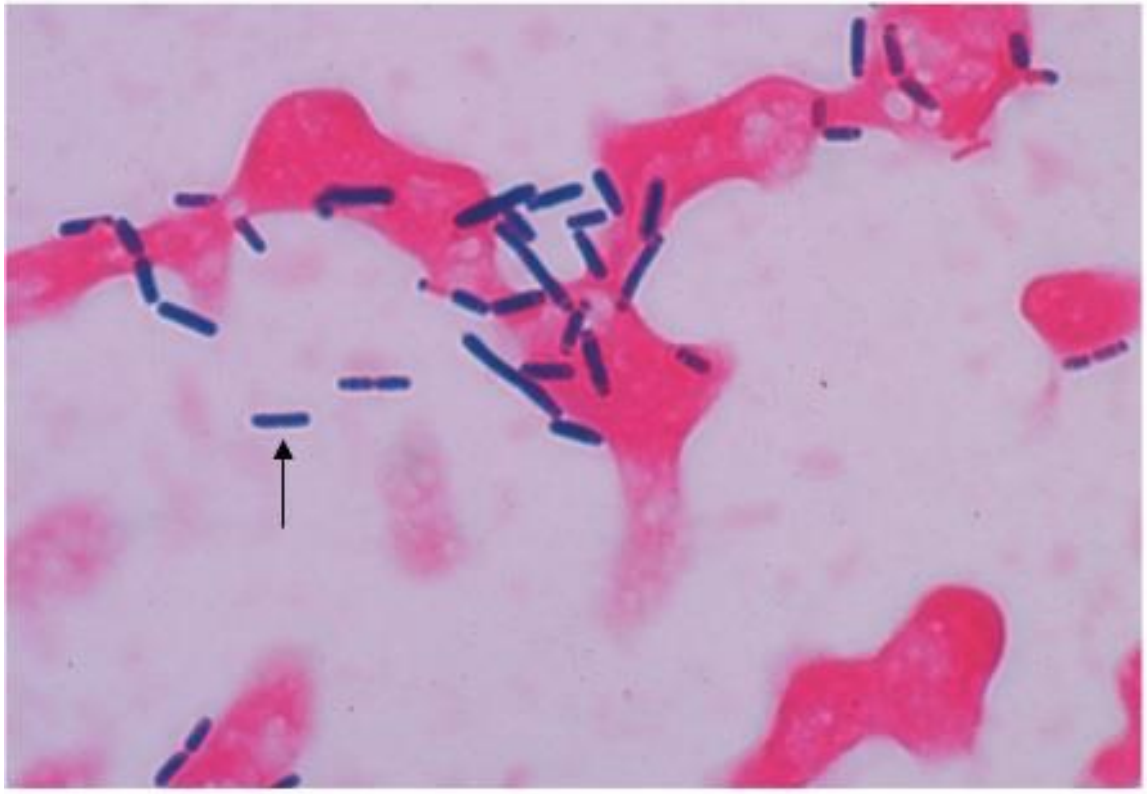
Bone and joint infections

- Joint redness and tenderness in a young adult may be due to Neisseria gonorrheae.
- Osteomyelitis is characterized by bone pain, fever, malaise, night sweats.
- May follow trauma, puncture wounds (Pseudomonas aeruginosa), intravenous drug abuse (usually Staphylococcus aureus), urinary tract infection (Enterobacteriacae species).
- In sickle cell disease, consider Salmonella typhimurium.

Bone and joint infections

- IV lines may also provide an entry portal for skin organisms to infect bone.
- Mycobacterium tuberculosis and Pasturella multocida may also cause osteomyelitis as well.
- Clostridium perfringens should always be considered in deep muscle or soft tissue infections.

Gram stain (C. perfringens)



Source: Levinson W: *Review of Medical Microbiology and Immunology*, 10th Edition: http://www.accessmedicine.com

Color plate 6 Accessed 02/01/2010

Provider: Professor Shirley Lowe, University of California, San Francisco, School of Medicine

HBV Serology

- HBsAg appears before onset of symptoms, peaks during overt disease, and is generally undetectable after 3-6 months.
- HBeAg, HBV-DNA, and DNA polymerase appear in the serum soon after HBsAg. These indicate active viral replication.
- IgM-anti-HBc appears shortly before onset of symptoms, concurrent with rise in ALT/AST. After months, it is replaced with IgG-anti-HBV.

HIV screening recommendations

- Screen all newborns of HIV positive mothers. (PCR)
- Screen in those populations where prevalence of HIV positive is >1% (sexually transmitted disease clinics, prisons).
- Screen all pregnant women.
- Screen for HIV1/2 antibodies and p24 antigen
- RNA may be detected as early as 10 days post-infection;
- p24 antigen presents between 20-30 days post infection
- Anti-HIV antibodies develop over time