Infections Based on Predominant Disease Location (tropism)

ML Medicine Learning

Organisms Associated with Healthy Microbiome

- *Bacteroides* (GI tract)
- *Lactobacillus* (Vagina)
- *Staphylococcus epidermidis* (Skin)

Head

Central Nervous System (CNS)

- **Meningitis:** Differentiate by age (newborn, adult, elderly) and by "septic" (culture +) vs "aseptic" (culture negative - usually virus, prior antibiotics, or drug-induced).

  - **Bacteria:**
    - **Neonate**: *E. coli*, *Group B Strep*, *Listeria*
    - **Infant**: *Neisseria meningitidis*, *Strep pneumo*, *Haemophilus*
    - **Young Adult**: *Neisseria meningitidis*, *Strep pneumo*
    - **Elderly:** *Strep pneumo*, *Listeria*
    - **Aseptic bacterial causes (routine culture negative):** Spirochetes (*Treponema*, *Borrelia*, *Leptospira*), *Mycobacterium tuberculosis*, and fungi
    - **Others:** *Bacillus anthracis*, *B. cereus* (Wool-sorters and bioterrorism)
  - **Viruses (aseptic):**
    - **Enteroviruses**: most common (*including Coxsackievirus*, *Echovirus*, *Poliovirus*)
    - *Herpes simplex (HSV-2*, but increasing *HSV-1)*
    - **Others:** *HIV, West Nile, St. Louis Encephalitis*, *Mumps*, *Lymphocytic choriomeningitis (LCM)*, *Lassa*, etc
  - **Fungi:** *Cryptococcus*, Coccidioidomycosis/*Coccidioides*, etc
  - **Parasites:** *Naegleria* (free-living amoeba), *Angiostrongylus* (eosinophilic meningitis)

- **Encephalitis:** *Herpes simplex* (esp. *HSV-1*), *HIV*, *Rabies*, ARBO Viruses, *JC virus*, Prions, *Listeria*, *Trypanosoma*

- **CNS Nodules and Cavities:** neurocysticercosis, toxoplasmosis (in immune suppressed), bacterial brain abscess (polymicrobial anaerobes, Strep, Staph, *Nocardia*).

Head, Ears, Eyes, Nose & Throat (HEENT)

- **Eye**

  - **Conjunctivitis:**
    - **Viruses**: *Adenovirus*, Measles, *Herpes simplex* (dendritic ulcerative keratitis), *Coxsackie*,
    - **Bacteria**: *Strep pneumo*, neonatal conjunctivitis (*Gonococcus* or *Chlamydia*, also called inclusion conjunctivitis), *Chlamydia trachomatis*, *Leptospira*.
    - **Parasites**: *Acanthamoeba*, *Loa loa*/"eye worm"

  - **Periorbital infection or swelling:** Mucormycosis (in DKA), onchocerciasis (nodules), trichinosis, Chagas's Disease (Romaña's sign). (Non-infectious causes include allergies, nephrotic syndrome, cavernous sinus thrombosis, and superior vena cava syndrome).
  - **Retinitis:** *CMV*, *HIV*, *Toxoplasma* (less likely *Toxocara*, TB, *syphilis*, *Candida*, onchocerciasis)

- **Ear:** Otitis media/mastoiditis (*S. pneumoniae*, *H. influenzae*, *M. catarrhalis* (big three for otitis media), *Gp A Strep*, *Staph aureus*, many viruses), Otitis externa (*Pseudomonas*), Parotitis (*Mumps*, *Staph aureus*)

- **Sinuses:** Respiratory viruses (*Rhinoviruses*, *Adenovirus*, *Coronavirus*, *Influenza*), *Strep pneumo*, *Haemophilus*, *Moraxella*, Mucormycosis/Zygomycosis, *Aspergillus*

- **Facial cellulitis:** Group A Strep, Erythema infectiosa (Fifth's Disease/*Parvovirus*)

- **Pharyngitis/Epiglottitis:**

  - **Common:** Group A Strep, *EBV*, and respiratory viruses (*Rhinoviruses*, *Adenovirus*, etc)
  - **Less Common:** *Enteroviruses/Coxsackie* (Herpangina or Hand, Foot & Mouth disease), *CMV*, Group C & G Strep, STDs (*HSV*, *HIV*, Gonorrhea), and *Candida*
  - **Rare, but important:** Diphtheria (*Corynebacterium*), *Fusobacterium*, Epiglottitis (*H. influenzae*)
  - **Non-infectious causes**: Allergies, Smoking, GERD

- **Dental Infections:** *Strep viridans*, *Strep anginosus*, mixed anaerobes (*Fusobacterium*, *Prevotella*)

- **Dental Cavities:** *Streptococcus mutans*

Congenital Diseases

- **TORCH:** Toxoplasmosis, Others (syphilis, varicella-zoster, *Parvovirus* B19), *Rubella*, *Cytomegalovirus* (*CMV* most common), *Herpes simplex/HIV*.

Chest

Bronchitis/Pneumonia

- **Hemoptysis:** TB, necrotizing pneumonia (Staph aureus/Pneumococcus, etc), bronchitis, coccidioidomycosis, aspergilloma (fungus ball in pre-existing cavity), paragonimiasis (lung fluke), (other non-infectious causes such as lung cancer, lung infarct, lung vasculitis)
- **Bronchitis:** pertussis/"whooping cough" *(Bordetella pertussis)*, *H. influenzae*, *Moraxella*
- **Wheezing:** bronchiolitis (*RSV*, *parainfluenza*, *influenza*, etc), allergic bronchopulmonary aspergillosis (ABPA), parasites with lung migration (*Ascaris*, hookworm, *Strongyloides*, filaria)
- **Lobar Pneumonia:** *Streptococcus pneumoniae*/pneumococcus, *Klebsiella*, etc.
- **Diffuse Alveolar:** *Pneumocystis* (late), *Hanta virus*, *Pseudomonas* (esp. cystic fibrosis pts)
- **Interstitial:** viruses *(influenza*, *metapneumovirus*, *RSV)*, *Mycoplasma/Chlamydia*, *Pneumocystis* (early)
- **Nodular/Cavitary Disease:** mycobacteria, coccidioidomycosis, paragonimiasis, *Echinococcus*, etc

Heart and Mediastinum

- **Pericarditis:** mostly viruses (e.g. *Enteroviruses/Coxsackie*), TB
- **Myocarditis:** viruses (esp. *Enteroviruses/Coxsackie*), diphtheria, Chagas, trichinosis, toxoplasmosis,
- **Endocarditis:** acute and subacute: *Strep viridans*, *Enterococcus*, Staph, *Candida*, rheumatic fever
- **Mediastinitis**: anthrax (*Bacillus anthracis*), Post-op Staph, Strep

Abdomen

- **Gastritis/Gastric ulcers:** *Helicobacter pylori* (H. pylori)
- **Gastroenteritis/Colitis**
  - **Food poisoning:** *Staph aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Listeria*, *EHEC* (causes HUS)
  - **Non-Dysentery (watery diarrhea)**
    - Enteroviruses, *Norovirus* (cruise ships), *Rotavirus* (children in winter)
    - Enterotoxigenic E. coli (ETEC causes most traveler's diarrhea), Enteropathogenic E. coli (EPEC), cholera (Haiti, Africa, other travel), *Vibrio parahaemolyticus* (clam/shellfish), *Yersinia*
    - *Giardia* (camping/travel), *Cryptosporidium* (especially severe in HIV/AIDS), *Cyclospora*

- **Dysentery (fever, blood, and diarrhea):** *Shigella*, *Salmonella*, *Campylobacter*, enteroinvasive *E. coli (EIEC)*, Shiga toxin-producing *E. coli* (STEC, also called *enterohemorrhagic E. coli/EHEC*, causes 90% of hemolytic uremic syndrome/HUS in children - e.g. E. coli O157; H7), *Clostridium difficile*, amebiasis (*Entamoeba histolytica*)
- **Bowel obstruction:** *Ascaris*
- **Perianal itching and "itchy butt":** *Enterobius* (pinworms) and *Strongyloides*

- **Liver Disease**

  - **Hepatitis (increase AST/ALT) /Cirrhosis/Portal hypertension**
    - ***Hepatitis A*** **and** ***E*** (oral exposure) – acute only
    - ***Hepatitis B*** **and** ***C*** (parenteral exposure) – mostly chronic hepatitis → cirrhosis (acute uncommon)
    - ***Hepatitis Delta*** (Hep D can only co-infect a person with active Hep B, thus exacerbating hepatitis)
    - **Epstein-Barr virus (EBV) and Cytomegalovirus (CMV)**
    - **Other uncommon:** Yellow Fever, Leptospirosis, *Herpes simplex*, Visceral Leishmaniasis
    - **Schistosoma mansoni or japonicum** – Hepatic schistosomiasis causes portal hypertension, but no hepatocellular injury (i.e. no true hepatitis)
  - **Infiltrative Disease of Liver/Spleen:** Visceral Leishmaniasis, Miliary TB, Brucellosis,
  - **Obstructive Biliary Disease** (increased Alkaline Phosphatase and Bilirubin)
    - **Ascending Cholangitis:** Fever and RUQ abdominal pain from obstructed biliary tree, usually choledocholithiasis (stones in common duct), but also liver flukes (*Clonorchis*, *Fasciola*, *Fasciolopsis*), or round worms (*Ascaris*).
    - **Cholangiocarcinoma:** (esp. *Clonorchis/Opisthorchis*)

- **Genitourinary Tract / Sexual Transmitted Infections:**

  - **Cystitis/Pyelonephritis:** *E. coli*, *Enterococcus*, *Proteus*, *Klebsiella*, *Staph saprophyticus*, *Pseudomonas*, TB, *Schistosoma hematobium* (hematuria)
  - **Vaginitis:** bacterial vaginosis (*Gardnerella*), *Candida*, *Trichomonas*
  - **Cervicitis/Urethritis/PID:** *Neisseria gonorrhea*, *Chlamydia*, *Herpes simplex*, *HPV*, *Trichomonas*
  - **Genital Ulcers:** Syphilis/*Treponema pallidum*, *Herpes simplex*, Chancroid/*Haemophilus ducrey*i, etc.
  - **Genital Itching:** Candida, dermatophyte/tinea cruris, pediculosis/public lice, scabies

Extremities

- **Muscles:**

  - **Myalgia/Arthralgias** – *Influenza*, *Dengue*, *Chikungunya*, *Trichinella spiralis*
  - **Cellulitis** – *Group A Strep*, *Staph*, *Pasteurella multocida* (cat/dog bite), *Capnocytophaga* (dog bite)

- **Necrotizing fasciitis** – *Group A Streptococcus*, plus mixed anaerobes
- **Myonecrosis** – *Staph aureus* and *Clostridium* (gas gangrene)

- **Joints:** Septic arthritis – *Staph aureus* (MSSA/MRSA), GC, Lyme/*Borrelia burgdorferi*, TB, (reactive arthritis from *Campylobacter*, *Campylobacter*, etc.)

- **Lymphatics:** *Group A Strep*, *Staph aureus*, *Pasteurella*, tularemia/*Francisella tularensis*, lymphatic filariasis/esp. Wuchereria, Plague/*Yersinia pestis*, lymphocutaneous syndrome (*Sporothrix*, *Nocardia*, *Mycobacterium marinum*, cutaneous leishmaniasis), cat scratch fever/*Bartonella henselae*

- **Nails:** *Group A Strep*, *Staph aureus*, *Pasteurella*, tularemia/*Francisella tularensis*, lymphatic filariasis/esp. Wuchereria, Plague/*Yersinia pestis*, lymphocutaneous syndrome (*Sporothrix*, *Nocardia*, *Mycobacterium marinum*, cutaneous leishmaniasis), cat scratch fever/*Bartonella henselae*

Skin

- **Vascular Reactive**: e.g. erythema nodosum (assoc. with certain bacteria, viruses, fungi), erythema multiforme, hives

- **Dermatitis/Eczema:** e.g. impetigo (*Gp A Strep, Staph aureus*), folliculitis, erythema migrans (*Borrelia*), Tinea/dermatophytes, *Candida*, cutaneous larva migrans, onchocerciasis, injection drug use (e.g. MSSA/MRSA, *Clostridium*, *Eikenella*, *Pseudomonas*)

- **Vesiculobullous**: bullous impetigo, staphylococcal scalded skin, *Herpes simplex*, *Herpes zoster*, *Enterovirus/Coxsackie* (hand-foot and mouth disease or herpangina)

- **Maculopapular:** Measles/*rubeola*, *rubella*, roseola (*Human herpesvirus 6 - HHV-6*), *Molluscum*, *HPV*, etc.

- **Papulosquamous**: rarely infection related - Psoriasis, Lichen planus

- **Ulceronodular:** syphilis, chancroid/*Chlamydia trachomatis*), tularemia, sporotrichosis, *Nocardia*, atypical mycobacteria, disseminated blastomycosis, coccidioidomycosis, onchocerciasis, cutaneous leishmaniasis. Mixed organisms (diabetic foot ulcers). Kaposi sarcoma papules, nodules or plaques (*HHV-8*).

Systemic and/or Sepsis

- **Bacteria:** Endocarditis, Meningococcemia, Pneumococcemia in asplenic pt, Gram-negative sepsis (usually urinary, biliary or GI source), Neonatal sepsis (*Group B Strep/Streptococcus agalactiae*), Line sepsis, Toxic Shock (*Group A Strep or Staph aureus*), Tetanus, Botulism (*Clostridium botulinum*)

- **Atypical Bacteria (not taking a Gram stain)**: *Rickettsia* (RMSF, Typhus,) Spirochetes (Leptospirosis, Syphilis/*Treponema*, Lyme/*Borrelia burgdorferi*, Relapsing Fever/*Borrelia recurrentis*, etc.)

- **Viruses:** *HIV*, *Dengue*, *Ebola*, *Marburg*, etc

- **Fungus:** Candida line sepsis, disseminated coccidioidomycosis, histoplasmosis, blastomycosis, etc.
- **Parasites:** Malaria/*Plasmodium*, *Babesia*, *Trypanosoma brucei*, *Strongyloides* hyper-migration

Key Zoonoses

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Naturally transmitted from animals to humans

Arthropod-borne Bacteria & Parasites

- **Ticks:** Rickettsia (e.g. RMSF/R. rickettsii), African Tick-borne Fever/*Rickettsia*, Lyme Disease/*Borrelia burgdorferi*, Relapsing Fever/*Borrelia*, *Babesia*, *Anaplasma*, *Ehrlichia*
- **Mites/Chiggers:** Scrub typhus/*Orientia tsutsugamushi*, Scabies, Hair follicle mite/*Demodex*
- **Mosquitoes:** Malaria/*Plasmodium*, lymphatic filariasis/e.g. *Wuchereria*, (many ARBO viruses as above)
- **Fleas:** Endemic typhus/murine typhus/*Rickettsia typhi*, epidemic typhus/*Rickettsia prowazekii*, Tunga penetrans
- **Flies:** Sand Fly/*Phlebotomus-cutaneous* and visceral leishmaniasis, Tsetse Fly-African Sleeping Sickness/ T. brucei), Black Fly/*Simulium-Onchocerciasis*, Mango Fly/*Chrysops*-Loa Loa, Bot flies-Myiasis
- **Reduvid Bug:** Chagas/*T. cruzi*

Organism	Clinical	Reservoir	Risks	Micro
Pasteurella multocida	Bite wound infection, cellulitis	Dogs, Cats	Animal bites	Bipolar Gram-neg coccobacillus
Capnocytophaga	Bite wound infection, cellulitis, sepsis	Dogs>Cats	Animal bite in defic. Immunity/asplenia	Facultative anaerobic Gram-neg rod
Toxoplasma	1˚ mostly asympt, then cysts reactivate, esp. brain in HIV/AIDS	Cats	Cat litter, uncooked meat, pregnancy, decreased immunity	Protozoan parasite, non-motile
Bartonella	Cat-Scratch Fever, lymphadenitis, bacillary angiomatosis in AIDS	Cat bite, scratch or lick open wound	Cat contact, bite, scratch	Gram-neg coccobacillus – Warthin-Starry stain
Francisella tularensis	Skin ulcer, adenitis, pneumonia, sepsis	Rabbits, Wild animals, Pets, Ticks	Farmers, Hunters, Meat-handlers	Gram-neg coccobacillus
Brucella	Undulant Fever/FUO,	Cattle, Pigs, Goats,	Unpasteurized mild,	Gram-neg coccobacillus

	septic arthritis, SBE	Sheep	Animal abortions	
Yersinia pestis	Bubo, pneumonia	Prairie dogs, Rats	Rodent exposure	Bipolar Gram-neg rod
Y. enterocolitica	Gastroenteritis	Pigs	Undercooked pork	Bipolar Gram-neg rod
Chlamydia psittaci	Atypical pneumonia	Psittacine Birds	Cleaning bird cages	Elementary body
Coxiella (Q-Fever)	Atypical pneumonia, rare endocarditis	Cattle, Sheep, Goats	Farmers	Survives as extracellular spore
Leptospira	Sepsis, with hepatic and renal injury	Rodents, Cattle, Pigs, Dogs	Farmers, Animal urine in fresh water	Motile spirochete found in urine
Rabies	Encephalitis, "hydrophobia"	Bats, Dogs, Foxes, Raccoons, Skunks	Wild animal contact, some unrecognized	PCR test of nuchal skin bx or saliva x 3

Study Table: by Palpant. Underlined are most likely to be seen on exams.

* Elementary bodies (EB) and Reticular bodies (RB) are NOT usually seen on Gram-stain.

Other Important Zoonoses

- **Bacterial:**
  - *Bacillus anthracis*/Anthrax - cattle, sheep, goats
  - *Campylobacter jejuni* - pets, farms or wild animals
  - *Capnocytophaga* - dog bites>cat
  - *Leptospira* - cattle, rodents
  - *Borrelia burgdorferi*/Lyme - deer, rodents
  - *Borrelia spp*/Relapsing Fever - rodents, ticks
  - *Mycobacterium marinum* - fish
  - *Salmonella* - poultry, pets, farm animals
  - *Rickettsia rickettsiae*/RMSF - rodents, ticks
  - *Rickettsia typhi*/Murine typhus - rodents
- **Viral:** *ARBO viruses*, *Influenza virus*, *Hantavirus*, *Arenavirus*, *filovirus*
- **Fungal:**
  - *Trichophyton*/Tinea - rodent pets
  - *Cryptococcus* - pigeons, chickens
  - *Histoplasma* - bird droppings
- **Parasitic:**
  - *Cryptosporidium* - most vertebrate animals
  - *Giardia* - Beaver

- *Leishmania* - dogs
- Animal hookworm/Cutaneous Larva Migrans - dogs, cats
- *Toxocara*/Visceral larva migrans - dogs, cats

Outline of Parasitic Diseases and Organisms According to Site/Specimen

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- **Blood:** *Plasmodium*, *Babesia*, *Trypanosoma*, Microfilaria, (*Leishmania* and *Toxoplasma* can be blood-bourne, but are not usually seen on the peripheral blood smear)
- **CSF:** *Trypanosoma brucei*, *Naegleria*, *Angiostrongylus* (eosinophilic meningitis)
- **Brain:** Neurocysticercosis (*Tinea solium*), *Toxoplasma*
- **Eye:** *Acanthamoeba*, Toxoplasmosis, Onchocerciasis, Loa loa, visceral larva migrans (Toxocariasis)
- **Mouth/Throat:** *Ascaris*
- **Sputum/Lung:** *Ascaris*, *Strongyloides*, *Pneumocystis*, *Paragonimus*
- **Abdomen/Ascites:** Echinococcal cysts, *Entamoeba histolytica* (liver abscess), visceral leishmaniasis, *Schistosoma* portal hypertension with ascites, without cirrhosis
- **Stool:** Cysts and Trophozoites of many GI protozoa, Ova and parasite of most worms (larva of *Strongyloides*)
- **Urine:** Ova *Schistosoma hematobium*
- **Vaginal fluid:** *Trichomonas*
- **Lymphatics:** Microfilaria (e.g. *Wuchereria*), *Trypanosoma*
- **Muscle:** Trichinosis, Cysticercosis, Onchocerciasis
- **Skin:** Cutaneous larva migrans, cutaneous leishmaniasis, Onchocerciasis, myiasis, scabies, lice (and other ectoparasites)

Notable Bacterial Toxins and Mechanisms

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These are exemplars of the most notable toxins and their mechanisms. Organisms such as *Clostridia perfringens*, *Staphyloccoccus aureus*, and *Pseudomonas* have a variety of toxins, some of which use similar mechanisms.

Anthrax

A/B toxin with three-protein components. Cell binding component is called protective antigen. There are two enzyme components:

1. Edema factor acts as adenylate cyclase and increases intracellular cAMP which interferes with intracellular signaling of immune effector cells and disrupts water homeostasis
2. Lethal factor is metalloprotease that inhibits protein kinases that further disrupts intracellular signaling, eventually leading to apoptosis.

Tetanus

Tetanus is secreted metalloprotease that specifically binds to peripheral neurons and is then transported retrograde to CNS inhibitory neurons. In inhibitory neurons, it cleaves synaptobrevin which is necessary for vesicle fusion and release of GABA. The lack of inhibitory GABA leads to unopposed muscular excitation.

Botulism

Botulism is secreted metalloprotease that binds to peripheral motor neurons where it acts directly on the peripheral nerve, cleaving SNARE proteins that are necessary to vesicle fusion and release of acetylcholine. The lack of acetylcholine at the neuromuscular junction leads to flaccid paralysis of the muscle.

Clostridium difficile

C.diff Toxin A

Enterotoxin that acts as potent neutrophil attractant

C.diff Toxin B

Cytotoxin factor

C.diff Binary Toxin

Uncommon; adenosine diphosphate robosyltransferase that disrupts actin cystoskeleton leading to severe clinical disease.

Diphtheria Toxin

A/B Toxin. Enzymatic subunit A ADP-ribosyllates host eEF-2. eEf-2 is required for protein synthesis; when inactivated, protein synthesis in the cell shuts down.

Shiga

A/B toxin. B unit binds to glycolipid receptor on epithelial cells. The A unit crosses into the trans-golgi network then to cytoplasm. It enzymatically modifies the 28S-RNA where acyl tRNA binds. This alteration blocks protein synthesis, leading to cell death.

Cholera

A/B toxin. B subunit binds the toxin to the enterocyte. The A subunit activates adenylate cyclase by adding ADP-ribose to the stimulatory G-protein. The increase in cyclic AMP causes outflow of Cl and H20.

E.Coli

Labile Toxin

A/B toxin. B unit binds cell membrane. A unit catalyzed ADP-ribosylation of regulatory G-protein, allowing unopposed activity of adenylate cyclase system. In Enterocyte, the result is chloride secretion out of the cell and blockage of NaCl absorption. Heat-labile.

E. coli Stable Toxin

A/B toxin. A unit catalyzes guanylate cyclase. Increase in cyclic GMP causes net secretion of fluid and electrolytes into bowel lumen.

Pertussis Toxin

A/B toxin stimulates adenylate cyclase by adding ADP-ribose to inhibitory G-protein which prevents signal transduction and inhibits normal chemokine receptor action. The result is that lymphocytes do not migrate to tissue and remain in circulation, leading to marked lymphocytosis, a clinical hallmark of pertussis infection.

Clostridia perfringens Enterotoxin (Food poisoning)

CPE enterotoxin that is secreted within the GI tract. It disrupts tight junctions between epithelial cells.