

The Physician Pharmacist: Bacteria/Fungi/Parasites

Stains:

-Gram Stain (Gm (+) purple, Gm (-) pink)

-Poor Gram Stainers:

- Treponema, Leptospira - too thin
- Mycobacteria - wall very lipidy
- Mycoplasma, Ureaplasma - No cell wall
- Legionella, Rickettsia, Chlamydia, Bartonella, Anaplasma, Ehrlichia - intracellular

-**Giemsa Stain** = Chlamydia, Rickettsia,

Trypanosomes, Borrelia, Helicobacter Plasmodium

-PAS = stains glycogen, (ddx Tropheryma Whipplei)

-Ziehl-Neelsen Stain (Carbol Fuchsin) = Acid-Fast Bacteria

-India Ink Stain = Cryptococcus neoformans

-Silver Stain = Fungi (Coccidioides, Pneumocystis jirovecii), Legionella, H. Pylori

-Fluorescent antibody stain = pneumocystis jirovecii, Giardia, Cryptosporidium

Medias:

-Thayer-Martin Agar = inhibits other growth to allow for selective growth of Neisseria

-**MacConkey Agar** = contains pH indicator; lactose fermenter (E.coli) to convert lactose to acidic metabolites (color changes pink)

-Chocolate Agar = H. influ

-Bordet-Gengou Agar = B pertussis

Tellurite Agar, Loeffler Medium = C diphtheria

-Lowenstein-Jensen, Middlebrook medium = M TB

-Eaton Agar = Myco Pneumoniae

-Eosin-methylene blue (EMB) = E coli

-Charcoal Yeast Extract (w/ Cysteine/Iron) = Brucella, Francisella, Legionella, Pasteurella

-Sabouraud Agar = Fungi "Sabs a Fun guy"

-Aerobes = use O₂-dependent system to generate ATP (Nocardia, Pseudomonas, Mycobacterium, Bordetella)

-Anaerobes = susceptible to oxidative damage (lack catalase/superoxide dismutase) (Clostridium, Bacteroides, Fusobacterium, Actinomyces)

-Facultative Anaerobes = use O₂ as a terminal electron acceptor to generate ATP, but can also use fermentation (O₂-independent path) (Strep, Staph, Enteric Gm (-))

-Obligate Intracellular (rely on Host ATP) = Rickettsia, Chlamydia, Coxiella

-Facultative Intracellular = Salmonella, Neisseria, Brucella, Mycobacterium, Listeria, Francisella, Legionella, Yersinia Pestis

Encapsulated Bacteria = "Please SHiNE SKiS"

-Capsular polysaccharide + protein conjugate serves as antigen in vaccines (protein added to immune response by activating T-cells and causing class switching;

Polycassarchides alone don't create a robust immune response b/c they can't be presented to T-cells)

-Body Opsonizes encapsulated bacteria and clears in spleen

-Asplenic = opsonization → severe infection (need vaccinations) = N. meningitidis, S. pneumo, H. influ

1. Pseudomonas
2. Strep pneumo
3. H. flu
4. Neisseria meningitidis
5. E. coli
6. Salmonella
7. Kleb pneumo
8. Group B Strep

-Pneumococcal Vaccines = PCV13 (conj), PPSV23 (polysaccharide only)

-H influenzae type B (HIB)(conj)

-Meningococcal Vaccine (conj)

Urease-Positive:

-urease hydrolyzes urea to release ammonia +CO₂ → pH - risk of Struvite Stones (Mag, Ammonium, Phos)

-Pee CHUNKS

1. Proteus
2. Cryptococcus
3. H. pylori
4. Ureaplasma
5. Nocardia
6. Kleb
7. S epidermidis
8. S saprophyticus

Spore-Forming: Gm (+) ONLY

-Dipicolinic Acid (Heat resistance)...autoclave to kill

-B anthracis (Anthrax), B cereus (Food Poisoning), C botulinum (Botulism), C difficile (Pseudomembranous colitis), C perfringens (Gas Gangrene), C tetani (Tetanus)

Catalase-(+)

-degrades H₂O₂ into water and bubbles of O₂ (before it can be used to kill bacteria by Myeloperoxidase)

-Chronic Granulomatous Dx (CGD) = defective NADPH oxidase → recurrent infxn

-SPANS BBLECH

1. Staph
2. Pseudomonas
3. Aspergillus
4. Nocardia
5. Serratia
6. Burkholderia
7. Bordetella
8. Listeria
9. E coli
10. Candida
11. Helicobacter Pylori

Pigment Producing:

-Actinomyces Israelii = Yellow "sulfur" granules

-S aureus = golden yellow

-P aeruginosa = blue-green pigment (pyocyanin and pyoverdin)

-Serratia Marcescens = red pigment

Biofilm Producing:

-S Epidermidis = Catheter and prosthetic devices

-Viridans strep (Mutans, Sanguinis) = dental plaques, infective endocarditis

-P aeruginosa = respiratory tree colonization w/ CF, VAP, contact lens associated Keratitis

-Nontypable (unencapsulated) H. flu = otitis Media

Virulence Factors: "promote invasion of host"

-**Protein A** = binds Fc region of IgG (preventing opsonization + phagocytosis) (Staph Aureus)

-**IgA Protease** = cleaves IgA allowing bacteria to adhere to/colonize mucous membranes (Strep Pneumo, H influ, Neisseria = **SHiN**)

-**M Protein** = prevents phagocytosis (Group A strep), similarity to Tropomyosin/Myosin → molecular mimicry → Rheumatic Fever

Bacterial Genetics:

Transformation:

- bind/import naked/environmental DNA (often from other bacterial cell lysis)
- ex.) Strep pneumo, H. influ, Neisseria (SHiN)
- adding Deoxyribonuclease degrades naked DNA

Conjugation:

- F+ x F-**
 - F+ plasmid contains gene required for sex pilus + conjugation
 - F- = lacking conjugation plasmid
 - F+ finds F- and sends over single strand DNA (ssDNA) Plasmid
 - Now both are F+
 - No Transfer of Chromosomal DNA occurs
- Hfr x F-**
 - F+ plasmid can become incorporated into bacterial chromosomal DNA (high-frequency Recombination Hfr Cell)
 - Results in transfer of Plasmid AND a few flanking genes**
 - Recipient is still F- but may now have new bacterial genes ("Recombinant F- Cell")

Transduction:

- Generalized:** "Packaging Error"
 - Lytic phage infects bacterium → leading to cleavage of bacterial DNA
 - Parts of bacterial DNA get packaged in phage capsid (and not the phages genes) → then infect another bacterium (transferring the Genes) but bacterium lives
- Specialized:** "Excision Event"
 - Lysogenic Phage infects bacteria → viral DNA incorporated into host DNA
 - Viral DNA excised + also pulls flanking bacterial DNA → gene transfer to new bacterium

-Lysogenic Phage = Group A Strep Erythrotoxic Tox, Botulinum tox, Cholera, Diphtheria, Shiga tox

Transposition: "Jumping"

- Transposon (specialized segment of DNA) = can copy and excise itself, then insert into same DNA molecule or unrelated DNA (plasmid/chromosome)
- Important for creating plasmids + MDR bugs via transfer across species lines

Exotoxins:

- secreted from cell
- polypeptide
- genes in plasmid or bacteriophage**
- highly toxic
- induces high-Titer antibodies called antitoxins
- Toxoids used as vaccines
- Destroyed rapidly at 60 degrees C (except staph enterotoxin, E coli Heat-stable toxin)
- ex.) Tetanus, Botulism, Diphtheria, Cholera

Inhibit Protein Synthesis: (EF-2 or 60S)

- Corynebacterium (Diphtheria Toxin)**
 - inactivates elongation factor (EF-2)
 - pharyngitis w/ pseudomembranes in throat + severe lymphadenopathy (bull neck), myocarditis

- Pseudomonas (Exotoxin A):**

- Inactivate elongation factor (EF-2)
- Host cell death

- Shigella spp (Shiga Toxin):**

- inactivates 60S ribosome → removing adenine from rRNA
- damages GI mucosa → dysentery
- Enhances cytokine release → Hemolytic-Uremic Syndrome (HUS); EHEC serotype O157:H7

- Enterohemorrhagic E coli (EHEC) (Shiga Toxin)**

- Same as above but EHEC does NOT invade host cells

Increase Fluid Secretion: (cAMP)

- Enterotoxigenic E Coli (ETEC)**

- **(Heat-Labile Toxin)** = over activates adenylate cyclase (cAMP) → Cl- secretion in gut + H₂O
- **(Heat-Stable Toxin)** = over activates guanylate cyclase → cGMP → reabsorption of NaCl/Water
- "Labile in the Air (AC), Stable on the Ground (GC)"

- Bacillus Anthracis (Anthrax Toxin):**

- mimics AC → cAMP → adenomatous cutaneous

- Vibrio Cholerae (Cholera Toxin):**

- Overactivates AC → cAMP
- Permanently activating Gs (GPCR)
- Voluminous "Rice-Water" Diarrhea

Inhibit Phagocytic Ability: (blocks Gi → cAMP)

- Bordetella Pertussis (Pertussis Toxin):**

- Inactivates Inhibitory Gi (GPCR) → activation of AC → cAMP
- Whooping Cough = child coughs on expiration and "whoops" on inspiration, post-tussive emesis in adults

Inhibit Release of NT: (SNARE)

- Clostridium Tetani (Tetanospasmin):**

- protease that cleaves SNARE (protein needed for NT release via vesicle fusion)
- prevents release of inhibitory GABA/Glycine (NTs from Renshaw cells in Spinal cord) → spastic paralysis, trismus (lockjaw)

- Clostridium Botulinum (Botulinum Toxin):**

- SNARE (same as above)
- Foodborne (preformed toxin injection or Infant botulism (ingestion of spores → then toxin produced))

Lyse Cell membranes:

- Clostridium Perfringens (Alpha Toxin):**

- phospholipase that degrades tissues/membrane

- Streptococcus Pyogenes (Streptolysin O):**

- protein degrades cell membrane
- Lyses RBCs → B-hemolysis (host Abs against toxin = ABO), titers ddx Rheumatic Fever

Superantigens Causing Shock: (APC MHC II Hijack)

- Staph Aureus (Toxic Shock Syndrome Toxin (TSST-1):**

- cross-links B region of TCR to MHC class II on APCs outside of the Antigen binding site → overwhelming release of IL-1, IL-2, IFN-g, TNF-a → shock
- Toxic Shock Syndrome = fever, rash, shock

- Streptococcus Pyogenes (Erythrotoxic Exotoxin A):**

- same mech as above
- "Scarlet Fever"

borders

Endotoxins:

- outer cell membrane of most Gm (-) bacteria
- NOT secreted
- Lipid A component of **LPS** (structural part of bacteria; released when lysed)
- Genes on Bacterial Chromosome
- Less Toxic
- Fever, shock (hypotension), DIC seen
- Induces TNF, IL-1, and IL-6
- Poorly Antigenic
- No toxoids formed, so no vaccine
- Stable at 100 degrees C
- ex.) Meningococemia

LPS: found outer membrane of Gm (-) (cocci/rods)
-composed of O-antigen + Core Polysaccharide, Lipid A (Toxic Component)
-released upon cell lysis (not actively released like Exotoxins)

-Effects:

1. **Macrophage activation (TLR4/ CD14)** →
 - a. IL-1 + IL-6 = Fever
 - b. TNF-a = Fever/Hypotension
 - c. Nitric Oxide = Hypotension
2. **Complement Activation:**
 - a. C3a → Histamine release (hypotension/edema)
 - b. C5a → Neutrophil chemotaxis
3. **Tissue Factor Activation** → coag cascade → DIC

-ENDOTOXINS:

1. Edema
2. NO
3. DIC/Death
4. Outer membrane
5. TNF-a
6. O-antigen + Core Poly + Lipid A
7. eXtremely heat stable
8. IL-1, IL-6
9. Neutrophil Chemotaxis
10. Shock

Gm (+) Bacteria:

Gm (+) Cocci Antibiotic Tests (to classify):

Staph:

-**Novobiocin** = **Sapro** Resistant (R), **Epidermidis** sensitive (S)

Strep:

-**Optochin** = **Strep Viridans (R)**, **Strep Pneumonia (S)** "OVRPS"

-**Bacitracin** = **Group B (R)** - **Strep agalactiae**, **Group A (S)** - **Strep Pyogenes**

A-hemolytic Bacteria:

-"Partial Hemolysis"

-gram (+) cocci

-partial oxidation of Hb causes greenish/brownish color w/o clearing around growth on blood agar

Bugs

-Strep Pneumo (catalase (-) , Optochin (S))

-Strep Viridans (catalase (-) , Optochin (R))

B-hemolytic:

-"Complete Hemolysis"

-pale/clear area surrounding colony on blood agar

Bugs:

-Staph aureus (Catalase (+) , Coagulase (+))***

-Strep Pyogenes (Group A) (catalase (-), Bacitracin (S))

-Strep Agalactiae (Group B) (catalase (-), Bacitracin (R))

Staphylococcus: "From Right to Left on Chart"

1. Staphylococcus Aureus:

-Gm (+), B-hemolytic, catalase (+), Coagulase (+), Cocci in clusters

-Protein A (Virulence factor) binds Fc-IgG → inhibition of complement activation + phagocytosis

-colonizes nares, ears, axilla, groin

-Sxs:

- A. Inflammatory Disease = Skin infxns, organ abscesses, pneumonia (often after influenza virus infection), Endocarditis, Septic arthritis, Osteomyelitis
- B. Toxin-Mediated Disease → Toxic Shock Syndrome (TSST-1), Scalded Skin Syndrome (Exfoliative Toxin), Rapid-onset food poisoning (Enterotoxins)

-TSST-1 (Superantigen) = binds to MHC II and TCRs → cousin polyclonal T-cell activation + massive cytokine

-MRSA = resistance from altered PBP (mecA gene), Panton-Valentine Leukocidin (PVL) toxin kills leukocytes/tissue necrosis

-Staph aureus food poisoning (ingestion of Preformed toxin) → short incubation (2-6 hrs) followed by nonbloody diarrhea/emesis (Enterotoxin is Heat Stable - not destroyed w/ cooking)

Staphylococcal Toxic Shock Syndrome (TSS):

-fever, vomiting, diarrhea, rash, desquamation, shock, organ failure

- AST/ALT/Bili

-Associated w/ Prolonged use of Nasal Packing + Vaginal Tampons***

-Different from **Strep Pyogenes TSS** (toxic shock-like syndrome w/ painful skin infection)

-Staph aureus = coagulase (+) → fibrin clot around itself → abscess formation common

2. Staphylococcus Epidermidis:

-Gm (+), catalase (+), coagulase (-), **Urease (+)** cocci in clusters

-Novobiocin Sensitive vs. Saproliticus being (R)

-Does NOT ferment mannitol (Staph aureus does)

-Normal flora of skin (often contaminates Blood cultures)

-Infects Prosthetic Devices (Hip implants, Valves) + IV Catheters (Strong Biofilm Production)

3. Staphylococcus Saprophyticus:

-Gm (+), catalase (+), coag (-), **Urease (+)**, cocci in clusters

-Novobiocin Resistant (R)

-Normal flora of female genital tract/perineum

-2nd most common cause of uncomplicated UTI in young females (most common E.coli)

release

Streptococcus: “From Left to Right on Chart”

1. Viridans Group Streptococci:

- Grm (+), a-hemolytic cocci, Optochin (R) and Bile Insoluble (Graph = Furthest to Left)
- Normal flora of Oropharynx
- Strep **Mutans** and Strep **Mitis** = dental caries
- Strep **Sanguinis** = makes dextrans to bind to fibrin-platelet aggregates on damaged heart valves (Subacute Bacterial Endocarditis)
- “Viridans group strep live in mouth, b/c they are not afraid **of-the-chin (Optochin Resistant)**”
- “Sanguinis = blood → Endocarditis”

2. Streptococcus Pneumoniae:

- gm (+), a-hemolytic, lancet-shaped diplococci
- Encapsulated
- IgA Protease
- Optochin (Sensitive), Bile Soluble
- “Pneumococcus” = accosted w/ “**Rusty**” Sputum
- risk in Asplenic pts
- no virulence w/o capsule
- Pneumococcal Vaccine Available
- Sxs: “MOPS”
 - Meningitis
 - Otitis Media (children)
 - Pneumonia
 - Sinusitis

3. Streptococcus Agalactiae (Group B):

- Grm (+), B-hemolytic, Bacitracin Resistant, Hippurate (+), PYR (-)
- colonizes vagina (important for Pregnancy/Delivery)
- Causes Pneumonia, Meningitis, Sepsis (mainly in **Babies**)
- Polysaccharide Capsule confers virulence
- Produces CAMP factor = enlarges area of hemolysis formed by Staph Aureus)
- Screen Pregnant Pts at 35-37 weeks gestation w/ Rectal/Vaginal Swabs**
- (+) Culture = intrapartum PCN/Ampicillin PPx**

4. Streptococcus Pyogenes (Group A):

- grm (+), B-hemolytic, Bacitracin (S), PYR (+), cocci in Chains
- Types:
 - Pyogenic = pharyngitis, cellulitis, impetigo (“Honey-Crusted” Lesions), Erysipelas
 - Toxigenic = scarlet fever, TSS, Necrotizing Fasciitis
 - Immunologic = Rheumatic Fever, Glomerulonephritis (PSGN - Type III HSR, Periorbital Edema, IC deposition into GBM, Granular presentation on IF, C3 due to consumption, IgG, IgM)
- Hyaluronic Acid Capsule and M protein inhibit phagocytosis
- antibodies to M protein enhance host defenses against Strep Pyogenes but give rise to Rheumatic Fever
- DDx Strep Pharyngitis (Strep Throat) = throat swab (rapid vs. cultured)
- “**PHyogenes PHaryngitis** → **rheumatic PHever + glomerulonePHritis**”
- Virulence Factors = DNase, Erythrogenic Exotoxin, Streptokinase, Streptolysin O
- DDx =ASO Titer or Anti-DNase B Abs indicate recent Strep Pyogenes infxn
- Scarlet Fever** = blanching, sandpaper-like body rash, strawberry tongue(not to confuse w/ Kawasaki Dx
- Medium Vessel Vasculitis), circumoral pallor in setting of Group A streptococcal Pharyngitis (erythrogenic Toxin (+))

5. Streptococcus Bovis:

- grm (+), Gamma-Hemolytic, cocci pairs/chains
- Colonizes Gut
- Strep **Gallolyticus** (S Bovis Type I) causes bacteremia + Subacute Endocarditis
- Endocarditis (+) Bovis = Colon Cancer**
 - “Bovis in the Blood, Cancer in the Colon”

Enterococcus:

- Grm (+), cocci, catalase (-), PYR (+), gamma-Hemolytic
- E faecalis + E faecium = normal colonic flora
- PCN G resistant, causing UTIs, Biliary Tract Infxns, Subacute Endocarditis (esp. After GU/GI procedures)
- VRE = nosocomial infxn
- Enterococcus are more resilient than Strep (can grow in 6.5% NaCl soln and bile)

Bacillus Anthracis:

- Grm (+), spore-forming rod
- produces Anthrax Toxin (exotoxin w/ Protective Antigen, Lethal Factor, Edema Factor)
- Polypeptide Capsule (Poly D-glutamate)
- Colonies w/ Halo and projections = **Medusa Head**
- 1. Cutaneous Anthrax:
 - Painless papule surround by vesicles → Ulcer w/ **Black Eschar** (painless, necrosis)
- 2. Pulmonary Anthrax:
 - Inhalation of spores (contaminated animals or bioweapon)
 - Flu-like Sxsw/ rapidly progressive fever, pulmonary hemorrhage, mediastinitis (Widened Mediastinum), shock
 - PPx w/ Cipro or Doxy if Exposed

Bacillus Cereus:

- Grm (+) rod
- causes food poisoning (spores survive cooking rice - “Reheated Rice Syndrome” (keeping rice warm results in germination of spores + enterotoxin formation)
- Emetic type = N/V 1-5 hrs later (Cereulide - preformed toxin)
- Diarrheal type = watery, nonbloody diarrhea, GI pain 8-18 hrs later
- Tx = supportive care (Antibiotic ineffective against toxins)

Clostridia:

-grm (+), spore-forming, obligate anaerobic rods
-**Tetanus Toxin + Botulinum Toxin** = proteases that cleave SNARE (NT transport)

1. Clostridium Tetani:

-noninvasive pathogen, remains localized to wound site

-creates **Tetanospasmin** (Exotoxin) → Tetanus

- Retrograde axonal transport to CNS → blocking release of GABA/Glycine from Renshaw cells in spinal cord
- Spastic Paralysis, Trismus (LockJaw), Risus Sardonius (Raised Eyebrows + Open Grin), Opisthotonos (Spasms of Spinal Extensors)

-Ppx = Tetanus Vaccine

-Tx = Antitoxin +/- vaccine booster, Antibiotics, Diazepam (spasms), Wound debridement

2. Clostridium Botulinum:

-produce Heat-labile Toxin (**HST**) = inhibits ACh release at NMJ → causing botulism

-**Honey Ingestion in Babies** → **Floppy Baby Syndrome**

-Adults = often exposure to preformed toxin in canned food

-Sxs:

- Diplopia
- Dysarthria
- Dysphagia
- Dyspnea
- Descending Flaccid Paralysis

-No Sensory deficiencies

-Tx = Human botulinum immunoglobulin

-Therapeutics = Botulinum Toxin A (Botox)

Injections for Focal Dystonia, Hyperhidrosis, Muscle Spasms, COsmetic Reduction of Facial Wrinkles

3. Clostridium Perfringens:

-produces **a-Toxin** (Lecithinase, Phospholipase) → causing myonecrosis (gas Gangrene - soft tissue crepitus) + Hemolysis

-Often in heavily spore-contaminated food (left standing too long) → spores germinate →

4. Clostridium Difficile: (C. Diff)

-produces **Toxins A + B** = damaging Enterocytes

-sxs = watery diarrhea → pseudomembranous colitis

-Presents usually secondary to Abx use (esp Clinda, Ampicillin, Cephalosporins, Fluororoquinolones) or Chronic PPI use

-Fulminant Infxn = Toxic megacolon, Ileus, Shock

-DDx = PCR or antigen detection of either Toxin in stool

-Tx = Oral Vancomycin or Fidaxomicin, Severe needs fecal microbiota transplant

Corynebacterium Diphtheriae:

-grm (+), rods w/ angular arrangements

-Respiratory droplet transmission

-Exotoxin production by B-prophage (Lysogenic Phage

-Transduction) → inhibits protein synthesis via

ADP-Ribosylation of EF-2 → leading to necrosis in

Pharynx, Cardiac, CNS tissues

-Sxs = **Pseudomembranous pharyngitis** (Gray-White Membrane) + **Lymphadenopathy** (Bull's Neck)

- Disseminated Toxin → Myocarditis, Arrhythmias, Neuropathies

-DDx = "Grm (+) Rods w/ Metachromatic (Blue/Red)

Granules + (+) Elek Test for Toxin"

-DDx = Toxoid Vaccine prevents diphtheria

-Media = Loeffler Media (Metachromatic granules) or Cysteine-Tellurite Agar (Black colonies)

-ABCDEFGF:

- ADP-Ribosylation (inhibiting protein synth)
- B-Prophage
- Corynebacterium
- Diphtheriae
- Elongation Factor-2
- Granules (Metachromatic -Red/Blue)

Listeria Monocytogenes:

-Grm (+), Facultative **Intracellular** Rod (lives in or out)

-Ingestion of **Unpasteurized Dairy + Cold Deli Meats**

-Transplacental Transmission/Vaginal at Birth (caution in pregnant pts diets)

-Grows better in cold temps (Cold Enrichment)

-"**Rocket Tails**" = actin polymerization allow intracellular movement + cell-to-cell spread across membranes (avoids Antibodies)

-**Tumbling motility in broth**

Grm(+), Long Branching Filaments (look like Fungi)

1. Nocardia:

-aerobe

-Acid Fast (weak response)

-Found in soil

-Causes pulmonary infxns in immunocompromised (mimicking TB - but negative PPD) + Cutaneous infxns after trauma + CNS Abscess

-Tx = Sulfonamides (Bactrim)

2. Actinomyces:

-Anaerobic

-NOT Acid Fast

-Normal oral, reproductive, GI flora

-Causes Oral/facial abscesses (drain through sinus tracts), Dental Caries/Extraction/Maxillofacial Trauma

-Yellow "Sulfur" Granules

-Causes PID w/ IUDs

-Tx = PCN

"SNAP = Sulfa → Nocardia, Actinomyces → PCN"

Mycobacterium:

-Acid Fast Rods (Pink Rods)

-Mycobacterium Tuberculosis (TB, often resistant to multiple drugs)

-M. Avium = intracellulare (causes disseminated, non-TB dx in AIDS (also resistant) - Pts get Azithro Ppx if CD4+ < 50

-M. Scrofulaceum = cervical lymphadenitis (children)

-M. Marinum = Hand infxn in aquarium handlers

-Sxs = Fever, night sweats, weight loss, cough, hemoptysis

-Cord factor creates "Serpentine Cord" appearance in virulent M TB Stains (activates Macrophages - Promoting Granuloma Formation) → inducing release of TNF-a

-Sulfatides (surface glycolipids) inhibit phagolysosomal fusion***

-PPD (+) if current infxn of Past exposure

-PPD (-) if no infxn or immunocompromised pts

-INT-g release assay (IGRA) ahs fewer false positives from BCG vaccination

vegetative bacteria --. heat-labile enterotoxin → late-onset (10-12 hrs) food poisoning, resolution in 24 hrs

Leprosy:

-"Hansen Dx"

-**Mycobacterium Leprae** (acid-fast bacillus) that likes Cold temperatures (infecting skin + superficial nerves)

-"Glove + Stocking" Loss of Sensation

-Can't be grown in a dish

-DDx via tissue biopsy or PCR

-Armadillos = Reservoir

-Types:

- **Lepromatous** = diffusely over the skin w/ leonine (lion-face) Facies + is communicable (w/ high bacterial load)
 - Seen in low Cell-mediated immunity w/ a Largely Th2 Response
 - Can be Lethal
- **Tuberculoid** = limited to hairless skin plaques, seen in High Cell-mediated immunity pts w/ largely Th1 Response (Macrophages)

-Tx = Dapsone + Rifampin for Tuberculoid, Clofazimin added for Lepromatous

-Causes = Amnionitis, Septicemia, Spont Abortion in pregnancy, **Granulomatosis Infantiseptica**, meningitis in immunocomp., mild gastroenteritis in healthy
-Tx = Ampicillin

Gm (-) Bacteria:

Neisseria:

-Grm (-), diplococci

-Metabolize Glc + Produce **IgA Proteases**

-Contain Lipooligosaccharides (**LOS**) w/ Strong Endotoxin Activity

1. Neisseria Gonorrhoeae:

-Often Intracellular (**within Neutrophils**)

-No polysaccharide capsule

-**No maltose acid detection (uses Glucose)**

-**No vaccine** due to antigenic variation of Pilus Proteins

-Sexually or Perinatally Transmitted

-Causes Gonorrhea, Septic Arthritis, Neonatal

Conjunctivitis (2-5 days after birth), Pelvic Inflammatory Dx (PID), Fitz-Hugh-Curtis Syndrome

-Diagnosed w/ NAAT

-Condoms Sexual transmission

-Erythromycin Eye Ointment prevents neonatal blindness

-Tx = Ceftriaxone + Azithro/Doxy (to cover coinfection w/ Chlamydia)

2. Neisseria Meningococci:

-Polysaccharide capsule present

-aMaltose Acid Detection (Uses Maltose + Glc for acid production)

-Vaccine available

-Transmitted via Respiratory/Oral Secretions (Close quarters - Army Barracks, College Dorms)

-Causes Meningococemia w/ Petechial Hemorrhages + Gangrene of toes, Meningitis, Waterhouse-Friderichsen Syndrome (Adrenal Insufficiency, Fever, DIC)

-Ddx = culture-based tests or PCR

-PPx = Rifampin, Cipro, Ceftriaxone for close contacts

-Tx = Ceftriaxone or PCN G

-Histo = **Caseating granulomas w/ central necrosis and Langhans Giant Cell** (Not the same as Langerhans Cells)

-Gross = **Ghon Complex**

-TB reactivation risk (TNF- α Inhibs, Transplant)

Haemophilus Influenzae:

- Small Gm (-), coccobacillary Rod

-Aerosol Transmission

-Nontypable (Unencapsulated) strains are the most common cause of mucosal infections (Otitis Media, COnjunctivitis, Bronchitis)

-produces **IgA protease**

-**Chocolate Agar Culture** - contains Factors V (NAD+) and X (Hematin) for Growth (can be grown w/ Staph Aureus)

-Sxs = "**EMOP**"

- **Epiglottitis** (Endoscopic view = "Cherry Red" in Children; "Thumb Sign" on lateral Neck via X Ray)
- **Meningitis**
- **Otitis Media**
- **Pneumonia**

-Vaccine = HIB (contains type B capsular polysaccharide conjugated w/ Diphtheria Toxoid) - Given btw 2-18 months of age

-Does NOT cause flu (Influenza Virus Does)

-Tx = Amoxicillin +/- Clavulanate for Mucosal Infxns, Ceftriaxone for Meningitis; Rifampin PPx for Close contacts

Bordetella Pertussis:

-Grm (-), aerobic coccobacillus

-Contains Pertussis Toxin (Diasables Gi → cAMP

-Clinical Stages:

1. **Catarrhal** = low-grade fevers, **Coryza**
2. **Paroxysmal** = paroxysms of intense cough followed by **inspiratory "Whoop"** (whooping cough), Posttussive Emesis
3. **Convalescent** = gradual recovery of chronic cough

-Vaccine = Tdap, DTaP

-Tx = Macrolides (Bactrim if allergy)

Brucella:

-Grm (-), aerobic coccobacillus

-Transmitted via ingestion of contaminated animal products (Unpasteurized Milk - Strep Agalactinae (Group B))

-Survives **INSIDE** Macrophages in the

Pseudomonas Aeruginosa:

-Aerobic, Motile, Catalase (+), Grm (-) Rod,
Non-Lactose Fermenting, Oxidase (+)

-Grape-like odor

-PSEUDOMONAS:

- Pneumonia
- Sepsis
- Ecthyma Gangrenosum
- UTIs
- DM
- Osteomyelitis
- Mucoid Polysaccharide Capsule (may contribute to chronic pneumonia in pts w/ CF due to Biofilm formation)
- Otitis Externa (swimmers ear)
- Nosocomial Infxns (Catheters, Equipment)
- Addiction (IV drug abuser)
- Skin infxns (Hot Tub Folliculitis, Wound Infxn in Burn Victims)

-Produces PEEPR:

- **Phospholipase C** = degrades cell membranes
- **Endotoxin** = Fever, Shock
- **Exotoxin A** = Inactivates EF2 (halting protein synthesis)
- Pigments = **Pyoverdin and Pyocyanin** (Blue-Green coloration)
- **ROS**

-Corneal Ulcers/Keratitis = contact lens wearers/Minor eye trauma

-**Ecthyma Gangrenosum**: Rapidly progressive necrotic cutaneous lesion caused by Pseudomonas Bacteremia (Immunocompromised Pts)

-Tx:

- Antipseudomonal PCNs + B-lactamase Inhibitor (Piperacillin-Tazobactam)
- Ceftazidime, Cefepime
- Monobactams (Aztreonam)
- Fluoroquinolones (Cipro/Levo)
- Carbapenems

Shigella:

-Grm (-) Rod, Non-lactose fermenting, Oxidase (-), can invade GI tract via M Cells of Peyer's Patches

-Humans Only

-Cell to Cell Transmission (No Hematogenous Spread)

-No H₂S production**

-No Flagella

-Endotoxin + Shiga Toxin (Enterotoxin)

-Low ID₅₀ = very small inoculum required for infxn

-Acid Stable (resistant to gastric acids)

-Shortens duration of Fecal excretion

-Immune response = **PMN infiltration**

-sxs = Crampy abd pain → tenesmus/bloody mucoid stools (Bacillary Dysentery)

-No vaccine

- 4 F's = Fingers, Flies, Food, Feces

-Worst to Mildest = S Dysenteriae > S Flexneri > S boydii > S sonnei

-Invasion of M-cells is KEY to pathogenicity

Salmonella:

-Grm (-) Rod, Non-lactose fermenting, Oxidase (-), can invade GI tract via M Cells of Peyer's Patches

1. Salmonella Typhi:

-Humans only

-Hematogenous Spread

-H₂S production (+)

-Flagella Present (Salmon Swim)

-Endotoxin **Vi Capsule**

-ID₅₀ = High - large inoculum required (acid-Labile - inactivated by Gastric Acid)

-Effect of Abx on Fecal Excretion = Prolongs duration

-Immune response = Primarily Monocytes (**Macrophages**)

-Sxs = Constipation followed by Diarrhea

-Vaccine = **Oral (Live Attenuated) or IM (Vi capsular polysaccharide)**

-Carrier state w/ Gallbladder Colonization

Typhoid Fever = Rose spots on Abd, constipation, abd pain, fever - Pulse/Temperature dissociation, GI ulceration, Hemorrhage

-Tx = Ceftriaxone or Fluoroquinolone

Reticuloendothelial System

-Forms Non-caseating Granulomas

-sxs = Indolent Fever, Night Sweats, Arthralgia

-Tx = Doxy + Rifampin or Streptomycin

2. Salmonella spp. (except Typhi):

-Humans + Animal reservoir

-Hematogenous Spread

-H₂S production (+)

-Flagella (+)

-Endotoxin

-ID₅₀ = High

-Effect of Antibiotics on Fecal Excretion = Prolongs Duration

-Immune Response = PMNs in disseminated dx

-sxs = Diarrhea (possibly bloody)

-No vaccine

-Poultry, Eggs, Pets, Turtles = common sources

-Tx = Abx NOT indicated

-Gastroenteritis is usually caused by non-typhoidal Salmonella

Yersinia Enterocolitica:

-Grm (-) pleomorphic rod/coccobacillus

-usually transmitted from Pet Feces (Cats, Dogs), Contaminated Milk, Pork

-Cause acute bloody diarrhea, pseudoappendicitis (Right lower abdominal pain due to mesenteric adenitis/terminal ileitis)

-Reactive Arthritis in Adults

Lactose-Fermenting Enteric Bacteria:

-Fermentation of Lactose → Pink Colonies on MacConkey Agar

-CEEKS:

- **Citrobacter (Fast)**
- **E coli (slow)**
- **Enterobacter (slow)**
- **Klebsiella (slow)**
- **Serratia (Fast)**

-Lactose → Glucose + Galactose

Escherichia Coli (E.coli):

-Grm (-), Indole (+) Rod

-Virulence factors:

- Fimbriae → Cystitis/ Pyelonephritis (P Pili)
- K Capsule = Pneumonia/Neonatal Meningitis
- LPS Endotoxin = Septic Shock

1. Enteroinvasive Ecoli (EIEC):

-microbe invades intestinal mucosa causing

Necrosis + inflammation (Dysentery)

-Similar manifestations to Shigella (Dysentery)

-**"EIEC for Invasive"**

2. Enterotoxigenic Ecoli (ETEC):

-Heat-Labile and Heat-Stable Enterotoxins

-No Inflammation or Invasion

-**"Traveler's Diarrhea"** (Watery)

-**"ETEC for Travelers"**

3. Enteropathogenic Ecoli (EPEC):

-No toxin produced

-Adheres to apical surface, flattened villi = preventing absorption of nutrients in GI

-Diarrhea in children

-**"EPEC for Peds"**

4. Enterohemorrhagic Ecoli (EHEC):

-**O157:H7** most common serotype (transmitted in Undercooked Meat, Raw leafy vegetables)

-**Shiga Toxin = Hemolytic-Uremic Syndrome****

Klebsiella:

-Grm (-) Rod

-intestinal flora that can cause lobar pneumonia

(commonly in Alcoholism - Aspiration pneumonia, or DM)

-Mucoid colonies (due to abundant polysaccharide capsules)

-Dark Red **"Currant Jelly Sputum"** (Blood/Mucus)

-Nosocomial UTIs common

-associated w/ MDR

-ABCDE's of Kleb:

- Aspiration Pneumonia
- abscess in lungs/liver
- Currant Jelly Sputum
- DM
- EtOH Overuse

Curved Rods, All Oxidase (+):

Campylobacter Jejuni:

-Grm (-), Comma/S-shaped (w/ polar flagella), Oxidase (+), grows at 42 degrees C ("Likes it hot")

-Major cause of **Bloody Diarrhea (esp in Children)**

-Fecal-Oral transmission through Person-to-Person

contact or Contaminated poultry/meat/unpasteurized milk

-Contact w/ Infected Animals (Dogs, Cats, Pigs) also a RF

-Commonly Antecedent to Guillain-Barre Syndrome (GBS) and Reactive Arthritis

Vibrio Cholerae:

-Grm (-), flagellated, Comma-Shaped, Oxidase (+), Grows in Alkaline Media (Basic)

-Endemic to developing countries

-sxs = Profuse Rice-water Diarrhea (Enterotoxin permanently activating Gs (GPCR) → cAMP)

-Sensitive to stomach acid (Acid Labile)

-Requires Large inoculum (High ID50), unless host has low Gastric acidity (PPIs, Achlorhydria)

-Transmission = contaminated water/uncooked food (Raw Shellfish)

-Tx = Oral rehydration therapy

Helicobacter Pylori:

-Curved, flagellated (Motile), Grm (-) rod

-Triple (+):

- Catalase (+)
- Oxidase (+)
- Urease (+)

-DDx = Urea breath test or Fecal Antigen Test

-Urease produces Ammonia → Alkaline

environment ensues (helps bacteria survive acidic stomach)

-Colonizes **Antrum of Stomach**

-Sxs = Gastritis, Peptic Ulcers (Esp. Duodenal)

- Risk of Peptic Ulcer Dx, Gastric

Adenocarcinoma, **MALT Lymphoma** ("Marginal"

Adult B-cell Lymphoma than can regress w/ H.

Pylori Eradication - t(11;18))

-Tx = **Triple Therapy (Amoxicillin (Metro if Allergy) + Clarithromycin + PPI) or Quadruple Therapy if Macrolide Resistance (Bismuth-Based)**

Not-Listed on Grm (-) Algorithm:

Burkholderia Cepacia:

-Grm (-), bacilli

-causes pneumonia in CF pts (Often MDR)

-(+ Infection is a Contraindication for getting a

Lung Transplant

-Associated w/ Poor outcomes

Legionella Pneumophila:

-Grm (-) Rod - but poorly stains (**Silver Stain Better**)

-Grown on **Charcoal Yeast Extract Medium w/ Iron and Cysteine**

-Potential for Hyponatremia

-Aerosol transmission from environmental water source habitat (air conditioning systems, hot water tanks) - **No person to person transmission**

(HUS) = Triad of Anemia, Thrombocytopenia, AKI due to microthrombi forming on damaged endothelium → mechanical hemolysis (schistocytes on peripheral blood smear, Platelet Consumption, RBF
-Dysentery = toxin alone causes necrosis + Inflammation.
-Does NOT ferment Sorbitol (all other E. coli do)
-**"EHEC for Hemorrhage, Hamburgers, HUS"**

Spirochetes:

-Spiral-Shaped Bacteria w/ Axial Filaments
-Includes:

- Leptospira
- Borrelia
- Treponema

-Only Borrelia can be visualized using aniline dyes (Wright or Giemsa Stain - too small)
-Treponema is visualized by dark-field microscopy or direct fluorescent antibody (DFA) Microscopy

1. Leptospira Interrogans:

-spirochete w/ hook-shaped ends found in water contaminated w/ animal urine
-**Leptospirosis** = flu-like sx's, myalgias (Classically of **Calves**), Jaundice, **Photophobia** w/ Conjunctival Suffusion (Erythema without Exudate); seen in Tropics/Surfers
-**Weil Disease** = (Icterohemorrhagic Leptospirosis) = severe form w/ Jaundice + Azotemia from Liver/Kidney Dx, Fever, Hemorrhage, Anemia

2. Lyme Disease:

-"Borrelia Burgdorferi"
-Ixodes deer tick transmits (also spreads Anaplasma spp. + Protozoa Babesia)
-Natural reservoir in mouse; deer are essential to tick life cycle (but don't harbor borrelia)
-Stages:
1. Stage 1 = Early Localized; **Erythema Migrans (Bull's-Eye) + Flu-like-Sxs**
2. Stage 2 = Early disseminated; secondary lesions carditis, AV block, **Bilateral facial nerve (Bells) Palsy**, Migratory myalgias/transient arthritis
3. Stage 3 = Late Disseminated: Encephalopathy, Chronic Arthritis, Peripheral Neuropathy
-"Lyme Pie to the FACE"

Vibrio Vulnificus:

-Gm (-) bacillus found in Marine Environments
-Severe wound infections or Septicemia due to exposure of contaminated sea water
-Presents as Cellulitis → Necrotizing fasciitis (esp if Liver dx present)
-Tx = requires surgical debridement

3. Syphilis:

-**Treponema Pallidum, DOC = PCN G (even if allergic)**

A. Primary Syphilis:

-localized dx w/ **Painless Chancre**
-Fluorescent or Dark-field Microscopy to Visualize treponemes in fluid from chancre
-VDRL (+)

B. Secondary Syphilis:

-disseminated dx w/ constitutional sx's, maculopapular **rash (palms/soles)**, **Condylomata Lata** (Smooth, painless, wart-like, white lesions on genitals), **Lymphadenopathy**, patchy hair loss
-Confirm w/ Dark-field microscopy
-Serologic Testing = VDRL/PRP (Nonspecific) + FTA-ABS (specific)
-"Secondary Syphilis = Systemic"

C. Latent Syphilis: (+) Serology w/o sx's

D. Tertiary Syphilis:

-Gummas (Chronic Granulomas), Aortitis (Vasa Vasorum Destruction), Neurosyphilis (Tabes Dorsalis - General Paresis), Argyll Robertson Pupil (Constricts w/ Accommodation but is NOT reactive to light)
-sx's = Broad-based Ataxia, (+) Romberg, Charcot Joint, Stroke w/o HTN
-Neurosyphilis? Test spinal fluid w/ VDRL, FTA, PCR

E. Congenital Syphilis:

-Facial Abnormalities:
• Rhagades = Linear scars at angle of mouth
• Snuffles = nasal discharge
• Saddle nose
• Notched (Hutchinson) Teeth
• Mulberry Molars
• Short Maxilla
• Saber shins

-Outbreaks associated w/ Cruise ships, nursing homes
-Tx = Macrolid or Quinolone (Atypicals)
Legionnaires Disease:
-severe pneumonia (often Unilateral + Lobar)
-Fever, GI, CNS sx's
-RF = Older age, smoking, chronic lung dx
Pontiac Fever = Mild Flu-like Sxs

Gardnerella Vaginalis:

-pleomorphic, gram-variable rod involved in bacterial vaginosis (**BV**)
-Gray vaginal discharge w/ fishy smell; Nonpainful (vs. Vaginitis)
-Associated w/ sexual activity (but Not sexually transmitted)
-mech = Lactobacilli (natural flora) → anaerobic bacterial overgrowth
-**Clue Cells (Vaginal epithelial cells covered in Gardnerella)** w/ stippled appearance along outer margin
-**(+) Amine Whiff Test** = mixing discharge seen w/ 10% KOH enhances Fishy Odor
-Vaginal **pH > 4.5** during infection
-Tx = **Metronidazole** or Clinda

Chlamydiae:

-Chlamydiae cannot make their own ATP (Obligate Intracellular Organisms that use host own ATP generating mechs)
-Cause Mucosal Infections
-2 Forms:
• Elementary Body = (Small, dense) is Infectious and Enters Cells Via Endocytosis; transforms into Reticulate Body
• Reticulate Body = Replicates in cell by Fission; reorganizes into elementary bodies
-**Chlamydia Trachomatis** = causes neonatal + follicular adult conjunctivitis, Nongonococcal urethritis, PID, Reactive Arthritis
-**Chlamydia Pneumoniae/Psittaci** = atypical pneumonia (transmitted by air) (Psittaci = Parrot Reservoir?)
-Chlamydia cell wall LACKS classic peptidoglycan (due to reduced muramic acid) = B-Lactams are useless

- **Facial Nerve Palsy (usually bilateral)**
- **Arthritis**
- **Cardiac Block (AV Block)**
- **Erythema Migrans**

-Tx = Doxycycline (1st line); Amoxicillin (Pregnant, Children < 8 yo), Ceftriaxone if severe

Lymphogranuloma Venereum:

-Primary infection - a self limited genital ulcer or papule often missed

-Large, tender inguinal/femoral lymphadenopathy (bubos - massive lymph nodes), Groove sign

-Chlamydia Trachomatis serotype L1, L2, L3

-Africa

-Tx = Doxy for 21 days

-Song:

- **LGV.... first lesion is hard to see**
- **The bubo is so groovyyyy**
- **Blame CT... 123... just use DOXY!**

Jarisch-Herxheimer Rxn:

-Flu-like sx's (Fever, Chills, HA, Myalgia) after Antibiotics are started due to host response to sudden release of bacterial antigens

Zoonotic Bacteria:

-"Infectious Disease transmitted btw animals + Humans"

1. Anaplasma spp = Anaplasmosis
 - a. **Ixodes** Ticks (live on deer/mice)
2. Bartonella spp = Cat Scratch Fever
 - a. Cat scratch
3. Borrelia Burgdorferi = Lyme Dx
 - a. **Ixodes** Tick
4. Borrelia Recurrentis = Relapsing Fever
 - a. Louse
5. Brucella Spp = Brucellosis/Indolent Fever
 - a. Unpasteurized dairy
6. Campylobacter = Bloody Diarrhea
 - a. Feces from pets/contaminated foods

- CN VIII Deafness

-Prevent = Tx early in pregnancy (placental transmission is often after 1st trimester)

Diagnosing Syphilis:

-VDRL/RPR = Non-specific (Non-Treponemal), get Titers (higher titers is more suggestive), reacts to beef cardiolipin

-FTA = Treponemal (often confirms)

-False Positive VDRL:

- Pregnancy, Viral Infxn (EBV, Hepatitis), Drugs (Chlorpromazine, Procainamide), Rheumatic Fever, **Lupus (Anticardiolipin Ab)**, Leprosy

12. Mycobacterium Leprae = Leprosy
 - a. Humans w/ Lepromatous Leprosy; Armadillos
13. Pasteurella Multocida = Cellulitis, Osteomyelitis
 - a. Animal Bite, Cats, Dogs
14. Rickettsia Prowazekii = Epidemic Typhus
 - a. Human to Human via Human Body Louse
15. Rickettsia Rickettsii = Rocky Mountain Spotted Fever
 - a. **Dermacentor** (Dog Tick)
16. Rickettsia Typhi = Endemic Typhus
 - a. Fleas
17. Salmonella Spp (except S typhi) = Diarrhea, Vomiting, fever, Abd Cramps
 - a. Reptiles/Poultry
18. Yersinia Pestis = Plague
 - a. Fleas (rats, prairie dogs)

Rickettsial Diseases and Vector-Borne Illnesses:

-Tx = Doxycycline for all

Rash Common:

1. Rocky Mountain Spotted Fever (RMSF):

-Rickettsia Rickettsii (Vector = Tick)

-South Atlantic States, esp North Carolina

-Rash typically starts at Wrists/Ankles → spreads to Trunk, Palms, Soles

-Triad:

1. HA
2. Fever
3. Rash (Vasculitis):
 - a. **Palms and Soles Rash** = CARS:
 - i. Coxsackievirus A (Hand/foot/mouth dx)

-DDx = PCR, Nucleic Acid Amplification Test (NAAT), Cytoplasmic Inclusions (Reticulate Bodies) on Giemsa Stain

-Tx = Doxycycline or Azithro (add Ceftriaxone in Gonorrhea)

-Serotypes:

- A,B,C = Africa, Blindness (follicular conjunctivitis), Chronic infxn
- D-K = Urethritis/PID, Ectopic Preg, Neonatal Pneumonia (Staccato cough)
- L1, L2, L3 - LGV

Rash is Uncommon/Rare:

"MEGA" = Monocytes, Ehrlichiosis; Granulocytes; Anaplasmosis

1. Ehrlichiosis:

-Ehrlichia (Vector = Tick)

-Monocytes (Macrophages) w/ Morulae

(Mulberry-Like Inclusions) in Cytoplasm

2. Anaplasmosis:

-Anaplasma (Vector = Tick)

Granulocytes w/ Morulae in Cytoplasm

3. Q-Fever:

-Coxiella Burnetii

No arthropod vector

-Bacterium inhaled as Aerosols from Cattle/Sheep amniotic fluid

-sxs = HA, Cough, Flu-like, Pneumonia

-Common cause of culture (-) Endocarditis

-"Q Fever is caused by a Quite Complicated Bug b/c it has no rash, no vector, its causative organism can survive outside its endospore form"

Mycoplasma Pneumoniae:

-Atypical "Walking Pneumonia"

-Insidious Onset, HA, Nonproductive cough, patchy, diffuse interstitial infiltrate, macular rash
-Frequently in < 30 yo population (Military, Prisons, Colleges)

-Tx = Macrolides, Doxycycline, Fluoroquinolones
-Not seen on gram stain (no cell wall) - PCNs don't work

-Pleomorphic

-Grows on Eaton Agar

7. Chlamydomydia Psittaci = Psittacosis
 - a. Parrots
8. Coxiella Burnetii = Q Fever
 - a. Aerosols of Cattle/Sheep Amniotic Fluid
9. Ehrlichia Chaffeensis = Ehrlichiosis
 - a. Amblyomma (Lone Star Tick)
10. Francisella Tularensis = Tularemia
 - a. Ticks, Rabbits, Deer Flies
11. Leptospira spp = Leptospirosis
 - a. Animal Urine

- ii. Rocky Mountain Spotted Fever
- iii. Secondary Syphilis

2. Typhus:

- Endemic (Fleas) - R typhi
- Epidemic (Human Body Louse) - R Prowazekii
- Rash Starts CENTRALLY → spreads out (sparing palms and soles)

- CXR appears more severe than pt presentation
- High Titer of **COLD Agglutinins (IgM)**
- Can cause atypical variant of Stevens-Johnson Syndrome (in Children and Adolescents)

Mycology: Fungal/Molds:

Systemic Mycoses:

- All can cause pneumonia + can disseminate
- Dimorphic fungi (cold 20C = Mold; Heat 37C = yeast) (Exception = Coccidioides is a Spherule in tissue, not a yeast)
- Can form Granulomas (Like TB)
- Cannot be transmitted person to person (unlike TB)
- Tx = Fluconazole or itraconazole for local Infxn, Amphotericin B for Systemic Infxn

1. Histoplasmosis:

- Mississippi + Ohio River valley
- Macrophage filled w/ Histoplasma (smaller than RBCs)
- Palatal/tongue ulcers, splenomegaly, pancytopenia, Erythema Nodosum
- "Histo Hides" (within macrophages)**
- Associated w/ Bird/Bat droppings (caves)
- DDx w/ Urine/Serum Antigen

2. Blastomycosis:

- Eastern + central US, Great Lakes
- Broad-Based Budding of Blastomyces (Same size as RBC)
- Inflammatory Lung Dx, Disseminates to bone/skin (**Verrucous Lesions**, may mimic SCC)
- "Blasto Buds Broadly"

3. Coccidioidomycosis:

- Southwestern US, California
- Spherule (Much Larger than RBC) filled w/ Endospores of Coccidioides
- Disseminates to bone/skin, **Erythema Nodosum** (Desert dumps) or **Erythema Multiforme**,

Cutaneous Mycosis:

1. Tinea (Dermatophytes):

- branching septate hyphae visible on KOH preparation w/ blue fungal stain (associated w/ Pruritus)
 - Tinea Capitis = head, scalp, + Lymphadenopathy, alopecia, scaling
 - Tinea Corporis = body/torso, enlarging erythematous, scaly rings ("Ringworm") w/ central clearing
 - Tinea Cruris = inguinal area ("jock itch") (often does not show central clearing seen in tinea corporis)
 - Tinea Pedis = "Athlete's Foot"
 - Interdigital (most common)
 - Moccasin Distribution
 - Vesicular Type
 - Tinea Unguium (Onychomycosis) - nails

2. Tinea (Pityriasis) Versicolor:

- "Malassezia spp. (Pityrosporum Spp)"
- yeast like fungus (NOT a dermatophyte despite being called tinea)
- Degradation of lipids produces acids that inhibit Tyrosinase (involved in Melanin Synthesis) → **Hypopigmentation**
- Less pruritic than Dermatophytes (less itchy)
- can occur at any time of year (hot, humid summers the worst)
- "Spaghetti + Meatballs" on microscopy
- Tx = Selenium Sulfide

Opportunistic Fungal Infections:

1. Candida Albicans:

- Dimorphic; forming Pseudohyphae + budding yeasts in cold (20C) or germ tubes at hot (37C)

2. Aspergillus Fumigatus (Mold):

- Septate Hyphae branch @ 45 degree angles (**Acute Angle**)
- causes invasive aspergillosis (Granulomatous Dx - CGD → Catalase (+))
- Aspergillomas = balls of fungus, often forming in cavities secondary to TB infection
- Aflatoxins** = associated w/ hepatocellular carcinoma (HCC)
- Tx = Voriconazole > Echinocandins
- Allergic Bronchopulmonary Aspergillosis (ABPA):** HSR to aspergillus growing in lung mucus → associated w/ Asthma + CF (can cause Bronchiectasis + Eosinophilia)

3. Cryptococcus Neoformans:

- narrow budding, Heavily encapsulated yeast, NOT dimorphic
- soil, pigeon droppings
- inhalation w/ hematogenous dissemination to meninges
- India Ink** = "Clear Halo" and Muciarmine (Red Inner Capsule)
- Latex Agglutination** test detects polysaccharide capsular antigen
- Cryptococcosis, Cryptococcal Meningitis, Cryptococcal Encephalitis ("Soap Bubble Lesions") = all usually in Immunocompromised pts
- Tx = Amphotericin B + Flucytosine w/ Fluconazole followup

4. Mucor + Rhizopus Spp.

- Irregular, broad, nonseptate hyphae branching at **Wide angles**
- mucormycosis (DKA pts, Neutropenia/Leukemia)
- Inhalation of spores → fungi proliferation in BV Walls → penetrate **cribriform plate** and enter brain

Arthralgias (Desert Rheumatism), Meningitis
-Associated w/ Dust exposure in endemic areas
(Archeological Excavations, earthquakes)

4. Para-Coccidiomycosis:

-Latin America

-Budding yeast of *Paracoccidioides* w/ “**Captain’s Wheel**” formation (much Larger than RBC)
-sxs similar to Blastomycosis
-Males > Females
-“*Paracoccidio parasails* w/ the Captain’s Wheel all the way to Latin America”

Pneumocystis Jirovecii:

-causing pneumocystis pneumonia (PCP) = diffuse interstitial pneumonia
-Most infxns are asymptomatic (unless AIDS/Immunosuppressive Tx)
-Sxs = Bilateral Ground-Glass Opacities on Chest imaging w/ Pneumatoceles
-DDx = BAL or Lung Biopsy
-Disc shaped yeast seen on Methenamine Silver Stain of Lung Tissue (or w/ Fluorescent Antibody)
-Tx/PPx = Bactrim, Pentamidine, Dapsone, Atovaquone
-Ppx = start when CD4+ cell count drops to < 200

Sporothrix Schenckii:

-“**Rose Gardener’s Disease**”
-Causes Sporotrichosis
-Dimorphic fungi
-exists as **Cigar-shaped** yeast at 37C in human body and Hyphase w/ spores in soil
-Lives on Vegetation (often infected from traumatic exposure to skin via Thorn)
-cause local pustule or ulcer w/ nodules along draining lymphatics (**Ascending Lymphangitis**)
-Disseminated dx possible in immunocompromised host
-Tx = Itraconazole or **Potassium Iodide**
-“Rose-Gardener who Spor-adically smokes Cigars and Pot (K+)”

-Systemic or superficial fungal infxn
-Oral/Esophageal Thrush (Neonates, Steroids, DM, AIDS), Vulvovaginitis (cottage cheese discharge), Diaper rash, Endocarditis, Disseminated candidiasis (neutropenic pts), Chronic Mucocutaneous Candidiasis
-Tx = Fluconazole, Nystatin, Echinocandins, Ampho B

Parasitology:

Protozoa - GI Infxns:

1. Giardia Lamblia:

-“Giardiasis” = bloating, flatulence, foul-smelling, nonbloody, fatty diarrhea
-Often seen w/ campers/hikers
-Cysts in contaminated natural water
-ddx = Multinucleated Trophozoites or Cysts in Stool via Antigen/PCR
-Tx = Metronidazole

2. Entamoeba Histolytica:

-“Amebiasis” = **BLOODY diarrhea (Dysentery), Liver abscess (“Anchovy Paste Exudate”)**, RUQ pain
-Colon Biopsy = “**Flask-Shaped Ulcers**”
-Cysts in contaminated water
-DDx = Serology, Antigen Testing, PCR, (+) Trophozoites (w/ engulfed RBCs in the Cytoplasm, Cysts in Stool w/ up to 4 nuclei)
-**Entamoeba Eats Erythrocytes (RBCs)*******
-Tx = Metronidazole, Paromomycins, Idoquinol

3. Cryptosporidium:

-Severe diarrhea in AIDS (mild dx in healthy pts)
-Oocysts in water
-ddx = Oocysts on acid-fast stain, Antigen detection, PCR
-Prevention = filtering city water

Protozoa - CNS Infxns:

1. Toxoplasma Gondii:

-Immunocompetent = mononucleosis-like sxs, (-)
Heterophile antibody test

-Rhinocebral, frontal lobe abscess; **Cavernous Sinus Thrombosis**
-HA, Facial pain, black necrotic eschar on face +/- cranial nerve involvement
-Tx = Surgical debridement, Amphotericin B or Isavuconazole (Cresemba)

2. Naegleria Fowleri:

-Rapidly fatal meningoencephalitis
-swimming in warm freshwater; enters via Cribriform plate
-ddx = Amoebas in CSF
-Tx = Amphotericin B (if they live long enough)

3. Trypanosoma Brucei:

-“**African Sleeping Sickness**”
-Enlarged Lymph nodes, Recurring Fever (due to antigenic variation), Somnolence, coma
-**Tsetse Fly** (painful bite)
-DDx = Trypomastigote in blood smear
-Tx = **Suramin** for Blood borne dx or **Melarsoprol** for CNS penetration

Protozoa - Hematological Infxns:

1. Plasmodium: (Malaria)

-fever, HA, anemia, Splenomegaly, hypoglycemia
-Subtypes:

- **P Vivax/Ovale** = 48 hr cycle (fever on 1st and 3rd day), dormant form (Hypnozoite) in Liver
- **P Falciparum** = severe; irregular fever patterns, parasitized RBCs occlude capillaries in brain → Cerebral Malaria), Kidneys, Lungs
- **P Malariae** = 72 hr cycle (Quartan)

-Transmission = **Anopheles Mosquito**
-Ddx = blood smear w/ Trophozoite ring form within RBC, Schizont containing Merozoites; Red Granules (Schuffner Stippling) throughout RBC cytoplasm seen w/ Vivax/Ovale
-Tx = Chloroquine > Mefloquine or

Protozoa - Others:

1. Trypanosoma Cruzi:

-”**Chagas Disease**” = dilated cardiomyopathy w/ apical atrophy, megacolon, megaesophagus
-mostly South America
-Unilateral Periorbital Swelling (Romana Sign) = indicating acute stage of dx
-Transmission via Triatomine Insect (“**Kissing Bug**”) bites and defecates around mouth or eyes → facial transmission into bite site/mucosa
-ddx = Trypomastigote in Blood smear
-Tx = Benznidazole, Nifurtimox

2. Leishmania spp.:

-**Visceral Leishmaniasis (Kala-azar)**: = spiking fevers, hepatosplenomegaly, pancytopenia***
-**Sandfly** transmission
-ddx = **Macrophages** containing Amastigotes
-Tx = Amphotericin B, Sodium Stibogluconate
-**Cutaneous Leishmaniasis** = simple skin ulcers

3. Trichomonas Vaginalis:

-**Vaginitis** = foul-smelling, greenish discharge; itching, burning
-Sexually transmitted (STI)
-ddx = Trophozoites (Motile) on Wet Mount; Punctate Cervical Hemorrhages (**Strawberry Cervix**)
-Tx = Metronidazole (also Treat Partners)

-Reactivation in AIDS → brain abscesses usually seen as **Multiple Ring-Enhancing Lesions on MRI**

-Congenital Toxoplasmosis = Classic Triad;

1. **Chorioretinitis**
2. **Hydrocephalus**
3. **Intracranial Calcifications**

-Cysts in meat (most common transmission), Oocysts in cat feces (Crosses Placenta - Pregnant patients should avoid cats)****

-Ddx = Biopsy (Tachyzoite), or Amniotic fluid for possible intrauterine dx

-Tx = Sulfadiazine + Pyrimethamine

-ppx = Bactrim (if CD4+ < 100)

Nematodes (Roundworms):

Routes of Infection:

1. Ingested (**EATTT**)= Enterobius, Ascaris, Toxocara, Trichinella, Trichuris
2. Cutaneous (**SAND**) = Strongyloides, Ancylostoma, Necator
3. Bites (**LOW**) = Loa loa, Onchocerca Volvulus, Wuchereria Bancrofti

Intestinal:

1. Enterobius Vermicularis (Pinworm):

-anal pruritus (**Tape Test** for eggs)
-Fecal-oral transmission
-Tx = Bendazoles, Pyrantel pamoate

2. Ascaris Lumbricoides (Giant Roundworm):

-obstruction at ileocecal valve, biliary obstruction, intestinal perforation, migrates from nose/mouth
-Migration of Larvae to alveoli in lungs → Loeffler Syndrome (Pulmonary Eosinophilia)
-Fecal-oral;knobby-coated , oval eggs seen in feces under microscope
-Tx = Bendazoles

3. Strongyloides Stercoralis (Threadworm):

-GI (Duodenitis), Pulmonary (Dry cough, hemoptysis), Cutaneous (Pruritus)
-Hyperinfection syndrome caused by autoinfection (larvae enter bloodstream)
-Larvae in soil penetrate skin → Rhabditiform larvae seen in feces under microscope

4. Ancylostoma spp. (Necator Americanus) (Hookworms):

Atovaquone/Proguanil (more severe)

-Life-threatening = Quinidine or Artesunate (check for G6PD def first)

-P vivax/Ovale = add Primaquine to also get the Hypnozoite (test for G6PD def)

2. Babesia:

-”Babesiosis” = fever, hemolytic anemia

-Northeastern/North Central US

-Asplenia → disease b/c of inability to clear infected RBCs

-**Ixodes Tick** (also Borrelia Burgdorferi/Anaplasma)

-ddx = Ring Form, **Maltese Cross**

-Tx = Atovaquone + Azithro

Tissue:

1. Toxocara Canis:

-Visceral Larva Migrans = Migration into blood → inflammation of liver, eyes (visual impairment, blindness), CNS (seizures, coma), Heart (Myocarditis)
-Pts often asymptomatic

2. Onchocerca Volvulus:

-skin changes, loss of elastic fibers, river blindness (Black skin nodules + Black Sight)
-Female “Black Fly”
-Tx = Ivermectin - “**Iver for rIVER blindness**”

3. Loa Loa:

-swelling in skin, **worm in conjunctiva (eye!!!)**
-Deer fly, horse fly, mango fly
-tx = Diethylcarbamazine

4. Wuchereria Bancrofti, Brugia Malayi:

-**Lymphatic Filariasis (Elephantiasis)**: = worms invade lymph nodes → inflammation → lymphedema → sxS onset after 9-12 months
-Female mosquito transmission
-Tx = Diethylcarbamazine

Cestodes (Tapeworms):

1. Taenia Solium:

- **Intestinal Tapeworm** = ingested larvae encysted in undercooked pork
- **Neurocysticercosis** = CNS infxn caused by pork tapeworm commonly from Latin America, Asia, Africa

-**microcytic anemia (IDA)** by sucking blood from intestinal wall
-Cutaneous Larva Migrans → pruritic, serpiginous rash
-Larva penetrate skin from walking **Barefoot**

5. Trichinella Spiralis:

-Larvae enter bloodstream, encyst in **striated muscle** → **myositis**
-**Trichinosis** = fever, vomiting, nausea, **periorbital edema, myalgias**
-Undercooked meat (Pork)

6. Trichuris Trichiura (Whipworm):

-asymptomatic; loose stools, anemia, rectal prolapse in children
-Fecal-oral route

Ectoparasites:

1. Sarcoptes Scabiei:

-Mites burrow into Stratum Corneum + cause **Scabies**
-Pruritus (worse at night) + Serpiginous Burrows - often btw fingers and toes
-Common in children, crowded population (Jails, nursing homes)
-Transmitted through skin to skin contact (or via fomites)
-Tx = Permethrin cream, oral Ivermectin, changing clothes/bedding

2. Pediculus Humanus/Phthirus Pubis:

-Blood-sucking lice → intense itching + Excoriations from response
-Scalp/Head, Axilla, Pubic/Perianal Lice
-Body lice can transmit Rickettsia Prowazekii (Epidemic Typhus), Borrelia Recurrentis (Relapsing Fever), Bartonella Quintana (Trench Fever)
-Tx = Pyrethroids, Ivermectin, Malathion, nit combing

- HA, Seizures, ICP,
- CT = Cystic, **Ring-enhancing, Calcified Lesions in Brain** Parenchyma, Meninges, Ventricles, Spinal Cord, Orbits

-Tx=Praziquantel, Albendazole (Neurocysticercosis)

2. Diphyllbothrium Latum:

-Vitamin B12 def (tapeworm competes for B12 in Intestine) → Megaloblastic Anemia (MCV > 100)
-ingestion of raw freshwater fish

3. Echinococcus Granulosus:

-Hydatid Cysts (**Eggshell Calcifications**) in Liver w/ rupture causing anaphylaxis
-Dog Feces + Sheep contamination

Trematodes (Flukes):

1. Schistosoma:

-Liver/Spleen Enlargement, Fibrosis, Inflammation, portal HTN
-Chronic infxn w/ S haematobium → **Squamous Cell carcinoma (SCC) of Bladder** (painless Hematuria) + Pulmonary HTN
-**Snails serve as host**
-Tx = Praziquantel

2. Clonorchis Sinensis:

-Biliary Tract Inflammation → Pigmented Gallstones
-Associated w/ Cholangiocarcinoma
-Undercooked Fish
-Tx = Praziquantel

Parasite Summary:

1. Biliary tract disease, Cholangiocarcinoma = **Clonorchis Sinensis**
 - a. Trematode/Fluke
2. Brain Cysts/Seizures = **Taenia Solium**
 - a. Neurocysticercosis - Cestode/Tapeworm
3. Hematuria, Squamous Cell Bladder Cancer (SCC) = **Schistosoma Haematobium**
 - a. Trematode/Fluke

4. Liver (Hydatid) Cysts, Exposure to Infected Dogs = **Echinococcus Granulosus**
 - a. Cestodes (Tapeworms)
5. Iron Deficiency Anemia = **Ancylostoma, Necator**
 - a. Suckling blood from intestinal wall (Hookworms) - Nematodes (Roundworms)
6. Myalgias, Periorbital Edema = **Trichinella Spiralis**
7. Nocturnal Perianal Pruritis = **Enterobius**
8. Portal HTN = **Schistomsoma Mansoni, Schistosoma Japonicum**
9. Vit B12 Def = **Diphyllobothrium Latum**

References:

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