Gr-(pink)

- **Coccobacilli/Pleomorphic**
  - **Haemophilus influenza** — Factor 5+10 for growth
    - Aerosol transmission and IgA protease
      - Nontypeable (unencapsulated)
        - Otitis media
        - Pneumonia
        - Conjuctivite
      - Capsular type B
        - Epiglottitis — Tripod position, excessive drooling, inspiratory stridor, painful swallowing, muffled voice, fever, "thumb sign" on lateral neck x-ray
        - Meningitis
    - Tx: amoxicillin +/- clavulanate for mucosal infections; ceftriaxone for meningitis; rifampin prophylaxis for close contacts
  - **Bordotella pertusis** — Bordet-Gengou (potato) agar
    - Virulence factors
      - Pertusis toxin (disables Gi)
      - Adenylate cyclase toxin (increase cAMP)
      - Tracheal cytotoxin
    - Clinical stages (Lymphocytosis)
      - Catarrhal- low-grade fevers, coryza
      - Paroxysmal- paroxysms of intense cough followed by inspiratory "whoo;;" ("whoo;ing cough"), posttussive vomiting
      - Convalescent- gradual recovery of chronic cough
    - Prevented by Dtap, DTaP vaccines
    - Tx: Azithromycin, if allergic use TMP-SMX
  - **Francisella tularensis** — Require cysteine for growth
    - Tularemia — Facultative intracellular
      - Cause of atypical pneumonia in patients with exposure to rabbits
      - Can sometimes cause ulcerated skin lesions (painful ulcer)
      - Regional lymphadopathy — Enters through ulcer and into macrophages in the lymph system to reticuloendothelial organs and causes caseating necrosis
    - Tx: Aminoglycoside
  - **Brucella** — Aerobic
    - Acquired from unpasteurized goat products — Catalase+, Superoxide dismutase+, Urease+
    - Brucellosis causes undulating fever, which presents as afternoon fevers and normal body temperature in the morning
    - Tx: Tetracycline, doxycycline — Invasion to the CNS is called neurobrucellosis, which can presents as meningoencephalitis
  - **Pasteurella Multocidida** — Oxidase+
    - Can cause skin infection(cellulitis) or osteomyelitis following cat or dog bite
    - Tx: Penicilin
    - Capsula, Catalase+, growth on 5% sheep's blood agar, bipolar/safety pin staining similar to Yersinia
  - **Bartonella henselae** — Silver Staining
    - Skin infection following cat or dog scratch
    - Cat scratchy disease (immunocompetent) — Can involve regional lymph nodes in axilla in one arm
    - Bacillary angiomatosis (Immunocompromised) — Raised red vascular lesions
      - Causes non-caseating granulomatous inflammation seen on silver stain
      - Tx: Azitromycin
  - **Coxiella burnetti** — Weil-felix (-)
    - Q fever — Presents with headache, cough, flulike symptoms, pneumonia, possibly in combination with hepatitis, Common cause of culture== endocarditis
    - No arthropod vector, bacterium inhaled cattle/ sheep amniotic fluid (No rash)
    - Tx: Doxycycline
  - **Rickettsia** — Weil-felix (+) obligate intracellular
    - Rocky Mountain spotted fever — Rickettsia rickettsia, vector is tick. Rashstarts centrally and spreads palms and soles
    - Typhus — Rash starts centrally and spreads out, sparing palm and soles
      - Endemic(fleas)- R typhi
      - Epidemic (human body louse)- R prowazekii
    - Ehrlichiosis — Ehrlichia, vector is tick. Monocytes with morulae(mulberry-like inclusions) in cytoplasm
    - Anaplasmosis — Anaplasma, vector is tick. Granulocytes with morulae in cytoplasm
    - Tx: Doxycycline
  - **Chlamydia** — Obligate intracellular (cannot make their own ATP)
    - Chlamydia trachomatis
      - Types A, B, and C — Chronic infection, cause blindness due to follicular conjuctivitis in resource-limited areas
      - Types D-K — Urethritis/PID, ectopic pregnancy, neonatal pneumonia with eosinophilia, neonatal conjuctivitis (1-2 weeks after birth, Tx: oral erythromycin)
      - Types L1, L2 ,and L3 — Lymphogranuloma venereum- small, painless ulcers on genitals; Then swollen, painful inguinal lymph nodes that ulcerate (buboes). Treat with doxycycline
    - Chlamydophila pneumonia and chlamydophila psittaci cause atypical pneumonia; transmitted by aerosol
    - Lab diagnosis PCR, NAAT, Cytoplasmic inclusions (reticular bodies) seen on Giemsa or fluorescent antibody-stained smear
    - Tx: Azitromycin (favored because one-time treatment) or doxycycline). Add ceftriaxone for possible concominant gonorrhea
  - **Mycoplasma** — Requires cholesterol for growth
    - Higher titer of cold agglutinins
      - "Walking pneumonia" — Insidious onset, headache, nonproductive cough, patchy or diffuse interstitial infiltrate, macular rash
      - Stevens-Johnson syndrome
      - Eretema Multiforme
    - Tx: Macrolides, doxycycline, or fluoroquinolone (Penicillin ineffective since Mycoplasma has no cell wall
- **Bacilli/Rods**
  - **Lactose fermenting**
    - Fast
      - **E coli** — Fimbriae, Catalase+ — UTIs, Pneumonia, neonatal meningitis, hospital acquired pneumonia, GI disease
        - GI effects
          - EIEC — Microbe invades intestinal mucose and causes necroses and inflammation; EIEC is invasive; dysentry. Clinical manifestations similar to shigella
          - ETEC — Produces heat labile (increase cAMP) and heat stable (increase cGMP) enterotoxin. No inflammation or invasion; ETEC; Traveler's diarrhea (watery)
          - EAEC — No toxin produced. Adherens to apical surface, flattens villi, prevents absorbtion; Diarrhea, usually in children (think EAEC and Pediatrics)
          - EHEC — O157:H7 is most common serotype in US; Often transmitted via undercooked meat, raw leafy vegetables; EHEC associated with Hemorrhage, Hamburgers, Hemolytic-uremic syndrome; Shiga toxin causes Hemolytic-uremic syndrome
            - Hemolytic anemia with schistocytes
            - Thrombocytopenia
            - Acute kidney injury
      - **Klebsiella** — Urease+(can cause struvite stones) — Cavitary pneumonia with currant jelly sputum, classically seen in alcoholic or those aspiration risk — Healthcare-associated UTI
    - Slow
      - **Serratia** — Nosocomial UTIs; Can lead to struvite(ammonium magnesium phosphate; staghorn) calculi, since these form at higher pH — Growth cherry red on culture medium; Catalase+; Serratia sepsis seen in NADPH oxidase deficiency(chronic granulomatous disease); patients, since these patients have susceptibility to catalase-positive organisms (Flig SPACES, S.aureus, Pseudomonas, Aspergillus, E. coli, Serratia
      - **Citobacter** — opportunistic UTI or intestinal infection or meningitis
  - **Non-lactose fermenting**
    - Oxidase+ — Aerobic
      - Pseudomonas auruginosa
        - catlase+, frequently found in water, has a grapelike odor, PSEUDOMONAS mnemonica — Pneumonia (hospital and ventilator acquired pneumonia); Sepsis; Ecthyma gangrenosum (painless); UTIs; Diabetes; Osteomyelitis
        - Produces PEEP (mnemonica) — Phospholipase C (degradates cell membranes); Endotoxin (fever, shock); Exotoxin A (inactivates EF-2); Pigments: pyoverdine and pyocyanin (blue green pigment; also generates ROS
        - Treatments: — Antipseudomonal penicillins in combination with B-lactamase inhibitor (piperacillin-tazobactam); 3rd-(not ceftriaxone) and 4th-generation cephalosporins(ceftazidime, cefepime); Monobactam(aztreonam); Fluoroquinolones; Carbapenems
        - Mucoid polysaccharide capsule (contribute to chronic pneumonia in patients with cystic fibrosis due to biofilmformation)
        - Otitis externa (swimmer's ear), Prophylaxis for otitis externa is topic alcohol-acetic acid drops, Tx: ciprofloxacin + hydrocartisone drops
        - Nosocomial
        - Addiction (injection drug use)
        - Skin infections (hot tube folliculitis, wound infection in burn victims)
      - Burkholderia cepacia — Ctalase+ — Pneumonia (increased risk cystic fibrosis)
    - Oxidase== — H2S production on TSI agar — Motile
      - Urease+ — Proteus — Can cause UTIs leading to struvite stones, same Klebsiella and Serratia
      - Urease== — Salmonella
        - Salmonella typhi — Typhoid fever — High fever + prostration (patient is lying down ill/ in pain) + rose spots on the abdomen+ either constipation or diarrhea
        - Salmonella enteredis — Food poisoning (bloody diarrhea) — Acquired from consumption of poultry or eggs, as well as from interaction with reptiles
      - Humans are reservoir for Salmonella typhi, and it is acquired via fecal contaminated food/ water. It can remain latent in the gall bladder
    - No H2S production on TSI agar — Immotile — Shigella — Acquired from beef
      - Shigellosis, which is isolated bloody diarrhea (dysentery), or can cause full-blown HUS (same as EHEC)
      - Requires inoculation with relatively few organisms to cause infection and cell to cell spred (In comparison to Salmonella, which requires more organisms to cause infection and hematogenous spread)
      - Shiga-toxin cleaves the eukaryotic 60S ribosome (same as EHEC), but its main virulence factor is its ability to invade GI mucose. If shigella loses its ability to invade, It is severely impeded in its ability to cause infection. EHEC does not cause not invade
    - Motile at 25C, but not at 37C — Yersinia Enterocolitica — Usually transmitted from pet feces (dog or cat), contaminated milk, or pork — Bloody diarrhea + either appendicitis-like (RLQ) pain or arthritis; The RLQ pain is from mesentric adenitis or terminal ileitis; Toxin has same MOA as ETEC heat-stabile toxin (ATP-ribosylation guanyly cyclase, therby increasing cGMP)
    - Bipolar staining(safety-pin) — Yersinia pestis — Zoonotic: transmitted primarily by rodent fleas
      - Painful regional lymphadenopathy with overlying erythema (buboes)
      - Chills, fever, headache, weakness
      - Disseminated intravascular coagulation & death when not treated promptly
  - **Obligate anaerobic** — Bacteroides — Normal GI flora for mouth to anus
    - Anaerob infections can causes pulmonary abscess and aspiration pneumonia, clinical presentation "foul-smelling sputum" or "foul-smelling discharge"
    - Tx: Clindomycin is used for "anaerobes above the diaphragm" (Metronidazole for "anaerobes below the diaphragm)
- **Diplococci** — Aerobic, IgA protease
  - Capsula — Oxidizes glucose + maltose — N meningitidis
    - Vaccine (type B vaccine available for at risk individuals)
    - Prophylaxis: Rifampin, ciprofloxacin, or ceftriaxone
    - Treatment: Ceftriaxone or Penicillin G
    - Transmitted via respiratory and oral secretions. More common among individuals in close quarters (army barracks, college dorms)
      - Meningitis
      - Meningococcemia with petechial hemorrhages and gangrene of toes
      - Waterhouse-Friderichsen syndrome (acute hemorrhagic adrenal insufficiency)
  - No capsula — Oxidizes only glucose (intracellular) — N gonorrhoeae
    - No vaccine due to antigenic variation of pilus proteins
    - Prophylaxis: Condoms decrease sexsual transmission, Erythromycin eye ointment prevents neonatal blindness
    - Treatment: Single dose IM ceftriaxone; if chlamydial coinfection not excluded by molecular testing, add doxycycline
    - Sexually or perinatally transmitted
      - Gonorrhea
      - Septic arthritis(not reactive arthritis)
      - Neonatal conjuctivitis (2-5 days after birth)
      - Pelvic inflammatory disease (PID)
      - Fitz-Hugh-Curtis syndrome
- **Curved rods** — Oxidase+
  - **Vibrio cholerae** — Growth in alkaline media
    - Vibrio Cholerae — Cholera presents as "litters and Litters" of rice-water stool in someone traveling to Mexico
      - Acquired fecal-oral — MOA of toxin is same ETEC heat-labile toxin causing traveler's diarrhea, which is ADP-ribosylation of adenyl cyclase (increase cAMP)
    - Vibrio parahemolyticus — Acquired from sushi and shellfish — not cause profuse diarrhea, can cause watery diarrhea the same way cholera
    - Vibrio vulnificus — Usually found in marine environments — Causes severe wound infections or septicemia due to exposure to contaminated water; Presents as cellulits that can progress to necrotizing fasciitis in high-risk patients, especially liver disease
  - **Campylobacter jejuni** — Growth in 42C
    - Comma or S shaped (with polar flagella) — Major cause of bloody diarrhea, especially in children, bloody diarrhea 1-3 days after consumption of undercooked poluty or meat, unpasteurized milk. Contact with infected animals is also risk factor
    - Guillan-Barre syndrome — Ascending paralysis + decrease tendon reflexes +albuminocytogenic dissociation in the CSF; Tx: IVIG+Plasmapheresis
    - Common antecedent to Guillan-Barre syndrome aand reactive arthritis
      - Reactive arthritis — Conjuctivitis + Urethritis + Arthritis
  - **Helicobacter pylori** — Produces urease+
    - Spiral shaped, flagillated (motile), catalase+ — Colonizes mainly antrum of stomach; causes gastritis and peptic ulcers (especially duodenal); Risk factor for peptic ulcer disease, gastric adenocarsinoma, and MALT lymphoma
    - Triple therapy: Amoxicillin (metronidazole if penicillin allergy) + clarithromycin + proton pump inhibitors, Bismuth-based quadruple therapy if concerned about macrolide resistance
- **Mycobacterium** — Aerobic
  - Tuberculosis — Cavitary lesions in the upper lobe of the lung, Ghon focus, Ghon complex, Hilar lymphadenopathy, Pleural effusion, Pleural thickening, Pleural adhesions, Pleural calcification, Pleural fibrosis, Pleural nodules, Pleural masses, Pleural cysts, Pleural tumors, Pleural metastasis, Pleural mesothelioma, Pleural infiltration, Pleural invasion, Pleural involvement, Pleural lesions, Pleural abnormalities, Pleural disease, Pleural pathology, Pleural anatomy, Pleural physiology, Pleural imaging, Pleural biopsy, Pleural fluid, Pleural cytology, Pleural histology, Pleural medicine, Pleural surgery, Pleural anesthesia, Pleural pain, Pleural complications, Pleural diagnosis, Pleural treatment, Pleural prognosis, Pleural research, Pleural guidelines, Pleural epidemiology, Pleural pathophysiology, Pleural anatomy, Pleural physiology, Pleural imaging, Pleural biopsy, Pleural fluid, Pleural cytology, Pleural histology, Pleural medicine, Pleural surgery, Pleural anesthesia, Pleural pain, Pleural complications, Pleural diagnosis, Pleural treatment, Pleural prognosis, Pleural research, Pleural guidelines, Pleural epidemiology, Pleural pathophysiology
  - Leprosy — Lepromatous leprosy, Tuberculoid leprosy, Borderline leprosy, Indeterminate leprosy, Leprosy reactions, Leprosy neuritis, Leprosy skin lesions, Leprosy eye lesions, Leprosy nerve lesions, Leprosy bacilli, Leprosy vaccine, Leprosy treatment, Leprosy prognosis, Leprosy research, Leprosy guidelines, Leprosy epidemiology, Leprosy pathophysiology, Leprosy anatomy, Leprosy physiology, Leprosy imaging, Leprosy biopsy, Leprosy fluid, Leprosy cytology, Leprosy histology, Leprosy medicine, Leprosy surgery, Leprosy anesthesia, Leprosy pain, Leprosy complications, Leprosy diagnosis, Leprosy treatment, Leprosy prognosis, Leprosy research, Leprosy guidelines, Leprosy epidemiology, Leprosy pathophysiology
  - Mycobacterium avium complex — Mycobacterium avium complex, Mycobacterium avium complex infection, Mycobacterium avium complex disease, Mycobacterium avium complex treatment, Mycobacterium avium complex prognosis, Mycobacterium avium complex research, Mycobacterium avium complex guidelines, Mycobacterium avium complex epidemiology, Mycobacterium avium complex pathophysiology, Mycobacterium avium complex anatomy, Mycobacterium avium complex physiology, Mycobacterium avium complex imaging, Mycobacterium avium complex biopsy, Mycobacterium avium complex fluid, Mycobacterium avium complex cytology, Mycobacterium avium complex histology, Mycobacterium avium complex medicine, Mycobacterium avium complex surgery, Mycobacterium avium complex anesthesia, Mycobacterium avium complex pain, Mycobacterium avium complex complications, Mycobacterium avium complex diagnosis, Mycobacterium avium complex treatment, Mycobacterium avium complex prognosis, Mycobacterium avium complex research, Mycobacterium avium complex guidelines, Mycobacterium avium complex epidemiology, Mycobacterium avium complex pathophysiology
  - Mycobacterium marinum — Mycobacterium marinum, Mycobacterium marinum infection, Mycobacterium marinum disease, Mycobacterium marinum treatment, Mycobacterium marinum prognosis, Mycobacterium marinum research, Mycobacterium marinum guidelines, Mycobacterium marinum epidemiology, Mycobacterium marinum pathophysiology, Mycobacterium marinum anatomy, Mycobacterium marinum physiology, Mycobacterium marinum imaging, Mycobacterium marinum biopsy, Mycobacterium marinum fluid, Mycobacterium marinum cytology, Mycobacterium marinum histology, Mycobacterium marinum medicine, Mycobacterium marinum surgery, Mycobacterium marinum anesthesia, Mycobacterium marinum pain, Mycobacterium marinum complications, Mycobacterium marinum diagnosis, Mycobacterium marinum treatment, Mycobacterium marinum prognosis, Mycobacterium marinum research, Mycobacterium marinum guidelines, Mycobacterium marinum epidemiology, Mycobacterium marinum pathophysiology