Microbiology Concept Maps

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Dr. Cannella did an amazing job of synthesizing what we covered in the microbiology lectures into systematic charts, emphasizing the high-yield facts. Sadly, he left UCSD after my year, but, with the help of the wonderful Dr. Sharon Reed, Dr. Sanjay Mehta, and Dr. David Pride, I have complied microbiology charts based on Dr. Cannella's charts and the information covered in lecture. The maps are designed with MindMaple software and are fully editable with the free software download. The lectures cover a great deal of information, so I hope these charts will help you better sort each microbe in a systematic way.

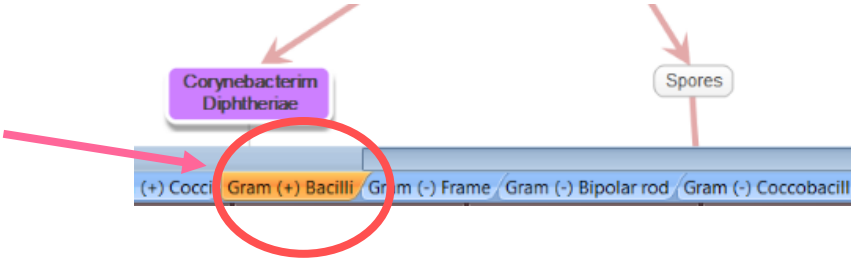
ISP Chair: Dr. Sharon Reed

ISP Committee Members: Dr. Sanjay Mehta & Dr. David Pride

1. Download + install **MindMaple Lite** (free software):
   http://www.mindmaple.com/Downloads/Windows/

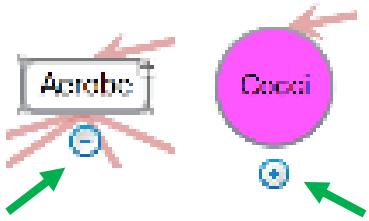
2. Open **Micro Concept Maps** file.

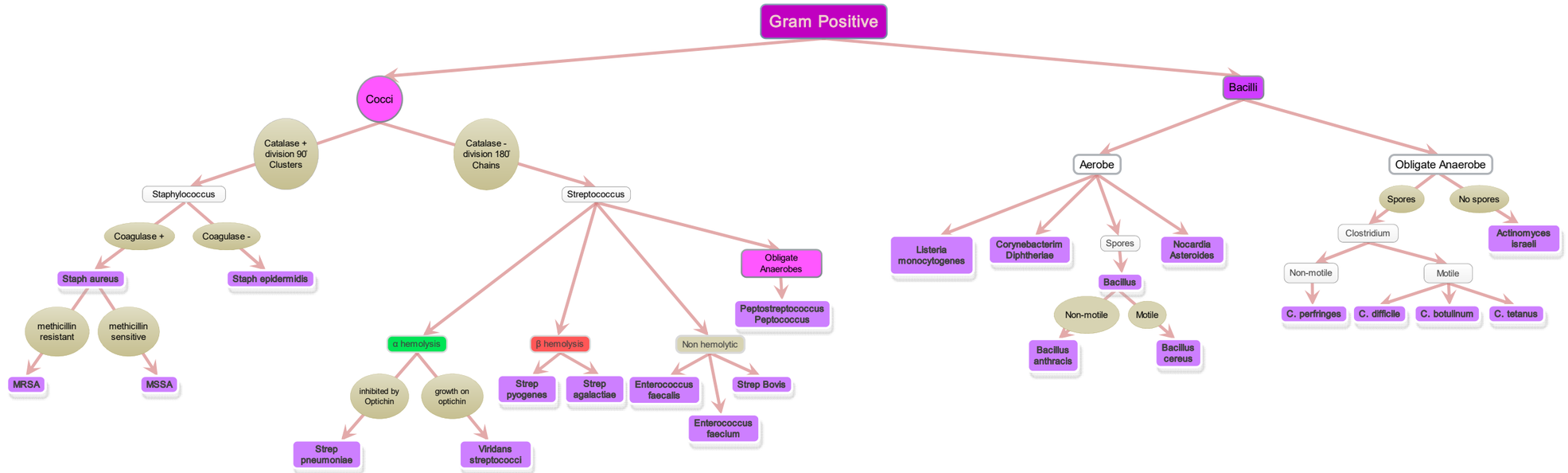
3. Toggle between the different maps using the tabs at the bottom of the screen.



4. Two categories of maps:
    a. Frame: outline of complete map
    b. Comprehensive maps: usually focused on a subset of a particular group

5. Branches can be hidden by clicking on (-) or revealed with (+).




Gram Positive
Cocci
Bacilli
Catalase + division 90° Clusters
Catalase - division 180° Chains
Staphylococcus
Streptococcus
Coagulase +
Coagulase -
Staph aureus
Staph epidermidis
methicillin resistant
methicillin sensitive
MRSA
MSSA
Obligate Anaerobes
Peptostreptococcus Peptococcus
α hemolysis
β hemolysis
Non hemolytic
inhibited by Optichin
growth on optichin
Strep pneumoniae
Viridans streptococci
Strep pyogenes
Strep agalactiae
Enterococcus faecalis
Strep Bovis
Enterococcus faecium
Aerobe
Obligate Anaerobe
Listeria monocytogenes
Corynebacterim Diphtheriae
Spores
Nocardia Asteroides
Bacillus
Non-motile
Motile
Bacillus anthracis
Bacillus cereus
Spores
No spores
Clostridium
Actinomyces israeli
Non-motile
Motile
C. perfringes
C. difficile
C. botulinum
C. tetanus

Gram Positive

Cocci

Catalase + division 90° Clusters

Staphylococcus

Coagulase +

Staph aureus

General:
- commonly colonizes the nose
- causes a broad range of diseases:
-exotoxin mediated disease
-direct organ invasion: skin infections, pneumonia, endocarditis, septic arthritis, osteomyelitis

Pathophysiology:

Many virulence factors:
- Penicillinase: breaks down penicillin > penicillin-resistance
- Protein A - binds to Fc portion of IgG, preventing opsonization and phagocytosis
- Coagulase - activates prothrombin > fibrin clot around bacteria protects it from phagocytosis
- Hyaluronidase & proteases: enables it to tunnel through tissue

Exotoxins:
- Exfoliatin Toxin A & B: diffusible toxin that cleaves the middle epidermis > scalded skin syndrome
- Toxic Shock Syndrome Toxin (TSST-1): superantigen that binds to MHC II and T cell receptors > TNF and IL-1 stimulation > massive immune response
- Enterotoxins: preformed, heat-stable toxin in contaminated food that stimulates peristalsis of intestine > gastroenteritis

Presentation:
- Gastroenteritis
-2-6 hour incubation time before symptoms
-non-bloody diarrhea and vomiting

- Scalded skin syndrome:
-fine sheets of skin peeling off revealing moist red skin underneath
-often seen in neonates or older children w/ skin infections

- Toxic Shock Syndrome:
-fever, rash, vomiting, desquamation, shock
-end organ damage (ARDS or acute renal failure)
-associated with prolonged tampon use

Diagnosis:
- produce golden pigment on sheep blood agar
- gram stain: gram (+) cocci in clusters

To distinguish from Strep:
- Wire loop test: check for catalase

To distinguish from other Staph species:
- Coagulase (+)

Tx:

methicillin resistant → **MRSA**

Resistant to methicillin and nafcillin
- acquired by mecA DNA segment which encodes penicillin binding protein, confering resistance against penicillinase-resistant penicillins and cephalosporins
- **treat with Vancomycin**

methicillin sensitive → **MSSA**

Cephazolin or Oxacillin

Coagulase -

Staph epidermidis

General:
- normal skin flora
- can migrate in through foley catheters or IV lines
- Novobiocin sensitive

Pathophysiology:
- polysaccaride capsule allows adherence to many surfaces
- produces biofilms > able to bind to prosthetic devices + protect from attack

Presentation:
- bacteremia
- sepsis

Diagnosis:
- Gram stain: gram (+) cocci in clusters
- coagulase (-)

Treatment:
Vancomycin (if significant infection)

Catalase - division 180° Chains

Streptococcus

α hemolysis

inhibited by Optochin

Strep pneumoniae

General:
- lancet-shaped diplococci
- encapsulated
- IgA protease

- major cause of bacterial pneumonia, meningitis, otitis media, and sinusitis in adults

Pathophysiology:
- Polysaccharide capsule protects against phagocytosis
- Asplenic patients particularly susceptible to sepsis

Presentation:
- Meningitis - nuchal rigidity, fevers, nausea

- Pneumococcal pneumonia - sudden onset of shaking chills, high fevers, chest pain, SOB. Consolidation made of WBCs, bacteria, and exudate. Cough up yellow-green phlegm

- Otitis media - middle ear infection in children

Diagnosis:
- Optochin (P disc) sensitivity helps differentiate S. pneumo from Viridans strep

Tx/Prevention:
- **Pneumococcal vaccine**
- Penicillins (depends on resistance pattern and type of infection

growth on Optochin

Viridans streptococci

General:
- part of normal GI tract flora
- often live in nasopharynx and gingival crevices

Pathophysiology:
- Bind to teeth leading to dental infections

Subacute Bacterial Endocarditis
> dental manipulation sends showers of organism into bloodstream
> implant on previously damaged heart valve (rheumatic fever)
> produce a dextran that allows them to cling to valve
>subacute bacterial endocarditis

Presentation:
Subacute bacterial endocarditis: low grade fevers, heart murmurs, anemia, fatigue

β hemolysis

Strep pyogenes

General:
- **Group A Strep**
- pus-producing

Pathophysiology:

Many virulence factors:
- M protein - inhibits complement activation and prevents phagocytosis, but antibodies form against M protein which can then cause **rheumatic fever**
- Streptolysin O - destroys RBC and WBC, ASO antibodies develop against antigen
- Pyrogenic exotoxin - found in a few strains of group A strep, cause scarlet fever and strep toxic shock syndrome

Delayed antibody-mediated response:
- antibodies that form against M protein during pharyngitis infection cross react with antigens on the heart > damage the heart, especially the mitral valve
- antibodies formed against pharynx or skin infection > strep antigen planted on glomerular basement membrane > antibodies bind to GBM > activation of complement > acute post-streptococcal glomerulonephritis

Presentation:
Diseases caused by local invasion/exotoxin
Streptococcal pharyngitis (Strep throat):
- red swollen tonsils and pharynx
- fever, swollen lymph nodes

Streptococcal skin infection
- erysipelas - infection of upper dermis
- cellulitus - infection of dermis and subQ fat
- impetigo - vesicular, blistered eruption around mouth
- Necrotizing fasciitis - spreads between subcutaneous tissue and muscle > bullae, skin death, and myositis

Scarlet fever
- pyrogenic toxin produces fever and scarlet-red rash
- rash starts axially and spreads to extremities, sparing the face

Streptococcal toxic shock syndrome
- similar to toxic shock caused by Staph aureus

Delayed antibody mediated diseases
Rheumatic fever
- **Occurs after untreated streptococcal pharyngitis**
- Fever, myocarditis, migratory arthritis, Sydenham's chorea, subcutaneous nodules, erythema marginatum
- can lead to long-term damage to heart valves + murmurs

Acute post-streptococcal glomerulonephritis
- coca-cola urine (hematuria)
- periorbital edema (fluid retention)
- high blood pressure

Diagnosis:
- Throat swab for Rapid Strep and/or culture
- Serum ASO titers for chronic infection

Tx/Prevention:
Penicillin G

Strep agalactiae

General:
- **Group B strep**
- 25% of women carry S.agalactiae vaginally, so babies can acquire during delivery
- common cause of meningitis in infants <3 months

Pathophysiology:
- babies infected during delivery > meningitis

Presentation:
Non-specific signs in neonates
- fever, vomiting, poor feeding, irritability

Diagnosis:
Lumbar puncture

Tx/Prevention:
- Screen pregnant women at 35-37 weeks and treat GBS+ women with **penicillin**

Non-hemolytic

Enterococcus faecalis & faecium

General:
- normal gut flora
- grow well in bile and 6.5% NaCl
- common nosocomial infection
- lots of drug resistance (vancomycin)

Pathophysiology:
- **In hospitalized patients**, commonly cause UTI, biliary tract infections, subacute endocarditis (post surgery)

Vancomycin Resistant Enterococcus (VRE):
- Chromosomal transposon vanA that changes peptidoglycan cell wall from D-ala-D-ala to D-ala-D-lactate
> low affinity for vancomycin
> **very difficult to treat**

Presentation:
Depends on type of infection

Diagnosis:
Culture

Tx/Prevention:
- **Ampicillin** or **Vancomycin** if sensitive
- **Daptomycin/linezolid** for VRE

Strep Bovis

General:
- normal gut flora
- grow well in bile
- can cause subacute endocarditis
- associated with **colon cancer**

Obligate Anaerobes

Peptostreptococcus Peptococcus

General:
- part of normal flora in mouth, vagina, and intestine
- mixed with other anaerobes in abscesses
- seen in aspiration pneumonia

Bacilli

Gram Positive

Cocci

Bacilli

Aerobe

Listeria monocytogenes

General:
- flagellated, tumbling motility
- facultative intracellular (hides inside cells to evade immune system)
- from unpasteurized dairy products and cold deli meats
- pregnant women should avoid dairy products/deli meats because listeria can infect the baby > neonatal meningitis

Tx:
Ampicillin

Corynebacterim Diphtheriae

General:
- Causes **diphtheria**
- colonizes the pharynx then produces exotoxins

Pathophysiology:
- forms grayish pseudomembrane in pharynx

Diphtheria toxin:
-B subunit: binds to heart and neural tissue
-A subunit: ADP ribosylates elongation factor (EF2), inhibiting translation of human mRNA into proteins

Presentation:
- myocarditis
- pseudomembranous pharyngitis (gray-white membrane)
- neural symptoms

Diagnosis:
- forms black colonies on tellurite agar

Prevention:
- **toxoid vaccine (DPT)**

Spores

Bacillus

Non-motile

Bacillus anthracis

General:
- causes anthrax (cutaneous and respiratory form)
- only bacterium with polypeptide capsule

Tx:
Ciprofloxacin

Motile

Bacillus cereus

General:
- commonly seen in reheated fried rice
- preformed exo-toxin causes food poisoning
- watery, nonbloody diarrhea
- no antibiotic treatment (since just pre-formed toxin)

Nocardia Asteroides

General:
- long, branching bacteria
- **Acid fast (weak)**
- inhaled and grows in the lungs > pulmonary infection
- causes lung + brain abscesses and cavitations

Tx:
TMP-SMX

Obligate Anaerobe

Spores

Clostridium

Non-motile

C. perfingens

General:
- often seen in soldiers wounded in battle
- spores are found in soil
- produces gas as it matures
- produces many types of exotoxins

Pathophysiology:
- enters body through wounds

<u>α toxin: lecithinase</u>
-most lethal exotoxin
-phospholipase that hydrozlyes lecithin in cell membranes
-causes cell death > gas gangrene

Presentation:
<u>Gas gangrene</u>
- pockets of gas within muscle and subcutaneous tissue
- thick blackish fluid exudes from skin

Diagnosis:
- Gram stain (many bacilli with few PMNS)
- Culture on blood agar with double zone of hemolysis

Tx/Prevention:
Surgical debridement and High dose penicillin

Motile

C. difficile

General:
- infection follows the use of broad spectrum antibiotics

Pathophysiology:
- antibiotics wipe out normal intestinal flora, allowing C.diff superinfection

- Exotoxins:
-<u>Exotoxin A</u>: binds to brush border of cut > diarrhea
-<u>Exotoxin B</u>: cytotoxin that kills colonic cells
-together they cause pseudomembranous colitis

Presentation:
- patient that develops diarrhea within a month of being on antibiotics

- Pseudomembranous colitis:
- severe diarrhea, abdominal cramping, fever
- blood and mucous can be present in stools
- red inflamed mucosa and areas of white exudate on large intestine (colonoscopy)

Diagnosis:
PCR testing for toxin A and B genes

Tx/Prevention:
- **discontinuing antibiotic**
- **Metronidazole**
- **oral Vancomycin**

C. botulinum

General:
- produces heat-labile neurotoxin > **blocks the release of ACh** from presynaptic nerve terminals > flaccid muscle paralysis

- Infant botulism: infants ingest food (typically honey) with C. botulinum spores > **floppy baby syndrome**
- Adult botulism: ingest preformed toxin from improperly canned foods > **descending paralysis**

C. tetanus

General:
- classically from rusty nail puncture wound

- Tetanospasmin:
-exotoxin that is transported to the CNS
-inhibits release of inhibitory neurotransmitters (GABA, glycine)
-allows upper motor neurons to send high frequency impulses to muscle cells
-causes tetany (sustained contraction), lockjaw, risus sardonicus

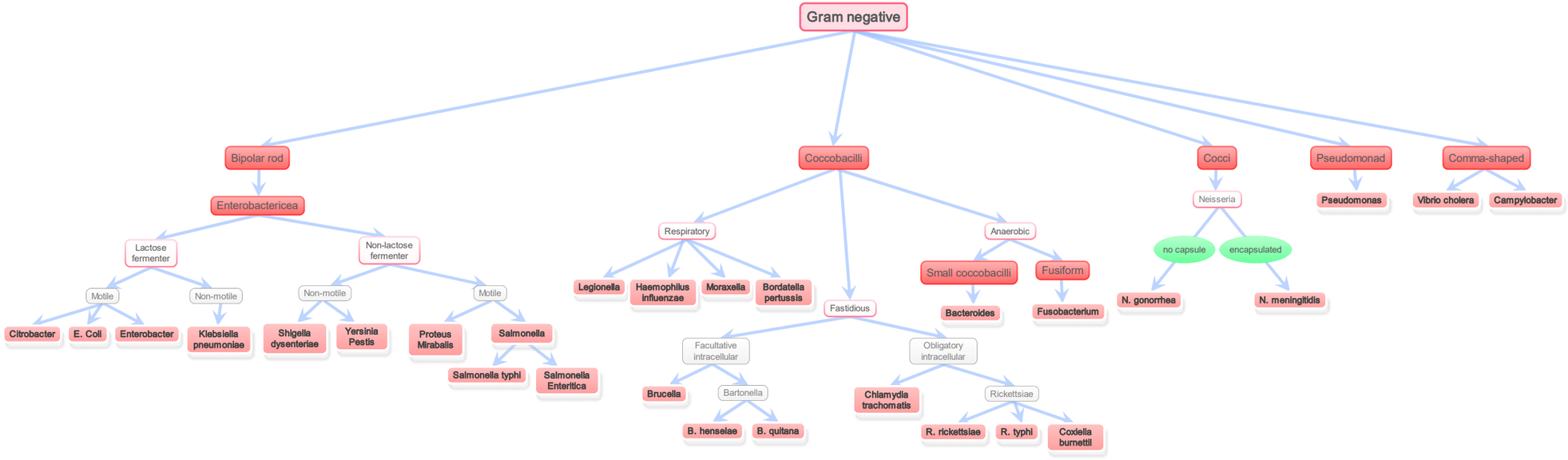
- **Tetanus vaccine** (part of DP**T**)

No spores

Actinomyces israeli

General:
- filamentous, branching bacteria
- normal oral flora
- not acid fast
- causes oral/facial abscesses
- produce yellow colonies called sulfur granules

Tx:
Penicillin G


Gram negative
Bipolar rod
Enterobactericea
Lactose fermenter
Motile
Citrobacter
E. Coli
Enterobacter
Non-motile
Klebsiella pneumoniae
Non-lactose fermenter
Non-motile
Shigella dysenteriae
Yersinia Pestis
Motile
Proteus Mirabalis
Salmonella
Salmonella typhi
Salmonella Enteritica
Coccobacilli
Respiratory
Legionella
Haemophilus influenzae
Moraxella
Bordatella pertussis
Fastidious
Facultative intracellular
Brucella
Bartonella
B. henselae
B. quitana
Obligatory intracellular
Chlamydia trachomatis
Rickettsiae
R. rickettsiae
R. typhi
Coxiella burnettil
Cocci
Neisseria
Anaerobic
Small coccobacilli
Bacteroides
Fusiform
Fusobacterium
Pseudomonad
Pseudomonas
Comma-shaped
Vibrio cholera
Campylobacter
no capsule
encapsulated
N. gonorrhea
N. meningitidis

Gram negative

- Bipolar rod
  - Enterobactericea
    - **Lactose fermenter**
      - Motile
        - **Citrobacter**
        - **E. Coli**
          - General:
            - Normal intestinal flora
            - Flagellated
            - Most common cause of UTI
            - Severity of disease determined by which virulence factors E.coli has acquired from plasmids
            - Transmission: fecal-oral
          - Pathophysiology:

            ETEC:
            - pili - helps bind to intestinal epithelium
            - Enterotoxins LT and ST - inhibit the reabsorption of Na+ and Cl- and stimulate secretion of Cl- and HCO3- into intestinal lumen
            > water follows osmotic pull > severe watery diarrhea

            EHEC: Strain O157:H7
            - pili - helps bind to intestinal epithelium
            - **Shiga-like toxin** - inhibit 60S ribosome > no protein synthesis > intestinal epithelial cell death
            > hemorrhagic diarrhea
            > vascular damage caused by shiga-like toxin associated with **Hemolytic uremic syndrome (HUS)**

            EIEC:
            - virulence factor > invasion of epithelial cells
            - Shiga-like toxin released
            - generates inflammatory reaction in host and necrosis > bloody diarrhea with WBCs
          - Presentation:

            ETEC:
            - people traveling in underdeveloped countries drinking contaminated water
            - **traveler's diarrhea** = severe watery diarrhea, rice water stool

            EHEC:
            - eating infected hamburger meat
            - dysentery (bloody diarrhea), severe abdominal cramps
            - **HUS: anemia, thrombocytopenia, renal failure**

            EIEC:
            - fever
            - dysentery with pus (WBCs)
          - Diagnosis:
            EMB agar - green sheen
            MacConkey agar - pink/purple
          - Tx/Prevention:
            Only treat invasive disease with Cipro or Cephalosporins
            Prevention: avoid raw food
        - **Enterobacter**
      - Non-motile
        - **Klebsiella pneumoniae**
          - General:
            - Encapsulated
            - Normal intestinal flora
            - Urease +
            - Disease commonly seen in alcoholics and diabetics
          - Pathophysiology:
            - Bacteria gets into respiratory tract from vomiting
            - Severe pneumonia that destroys lung tissue
            - Characterized by bloody sputum
          - Presentation:
            - **red current jelly sputum**
          - Diagnosis:
            Culture
          - Tx/Prevention:
            3rd generation cephalosporins
    - **Non-lactose fermenter**
      - Non-motile
        - **Shigella dysenteriae**
          - General:
            - Not part of normal intestinal flora
            - No flagella
            - Transmission: fecal-oral, eating raw food
          - Pathophysiology:

            (similar to EIEC)
            - invade intestinal epithelial cells
            - release **Shiga toxin**
            > intestinal cell destruction
            > inflammatory response
            > diarrhea results because inflamed colon unable to reabsorb fluids
          - Presentation:
            - fever, abdominal pain
            - dysentery with pus (WBCs)
            - colonoscopy shows shallow ulcers where cells have sloughed off
          - Diagnosis:
            Stool culture
          - Tx/Prevention:
            Avoid raw fruits and vegetables in developing countries
        - **Yersinia Pestis**
          - Cause of bubonic plague
          - only non-motile Yersinia
      - Motile
        - **Proteus Mirabalis**
          - General:
            - Highly motile, Urease +
            - Common cause of UTI and nosocomial infections
          - Pathophysiology:
            - Urease +: able to break down urea into NH3 and CO2
            > can live in urinary tract
          - Presentation:
            - Alkaline urine
            - UTI symptoms
          - Diagnosis:
            Swarming on agar
          - Tx/Prevention:
            P. mirabilis (not vulgaris) sensitive to Ampicillin
        - **Salmonella**
          - **Salmonella typhi**
            - General:
              - Not part of normal intestinal flora
              - Encapsulated
              - Small amt H2S production
              - Only carried by humans
              - Transmission: fecal-oral
            - Pathophysiology:
              - Invades intestinal epithelial cells
              >travels to regional lymph nodes
              >seeds in multiple organs by living **intracellularly** once phagocytosed by mΦ

              - Chronic carriers harbor S.typhi in their gallbladder

              - Sickle cell anemia patients with autosplenectomy are particularly prone to **Salmonella osteomyelitis**
            - Presentation:
              - eating at restaurants where cooks do not wash hands after going to the bathroom
              - Typhoid fever: fever, abdominal pain (can be over terminal ileum mimicking appendicitis), diarrhea, and rose spots on abdomen
            - Diagnosis:
              Stool, blood, or urine culture
            - Tx/Prevention:
              Vaccine (live-attenuated) prior to travel
          - **Salmonella Enteritica**
            - General:
              - Not part of normal intestnal flora
              - Non-lactose fermenter
              - Encapsulated
              - H2S production
              - Lives in the GI tracts of animals
              - Transmission: eating chicken and uncooked eggs, pet turtles (animals with cloacas b/c eggs are covered with fecal bacteria)
            - Pathophysiology:
              - endotoxin similar to cholera toxin causes watery or bloody diarrhea and inflammation
              - can disseminate throughout body
            - Presentation:
              Gastroenteritis: nausea, abdominal pain, fever, bloody/watery diarrhea
            - Diagnosis:
              Stool, blood, or urine culture
            - Tx/Prevention:
              Only fluid and electrolytes
              *antibiotics cause prolonged bacterial shedding in the stool
- Coccobacilli
- Cocci
- Pseudomonad
- Comma-shaped

Gram negative

Bipolar rod

Coccobacilli

Respiratory

Legionella

General
- aerobic
- facultative intracellular bacteria
- lives in moist environments - water parks, air conditioning, mist machines in supermarkets
- Famous for causing pneumonia outbreak at American Legion convention
- Transmission: inhaling water droplets

Pathophysiology:
Once inhaled, settles in lower respiratory tract
> alveolar mΦ phagocytose
> **survives inside mΦ** by inhibiting phagocyte-lysosome fusion
> produce toxins that cause respiratory disease

Presentation:
- Pontiac fever - flu-like illness with headache, muscle aches, fatigue, fever chills

- **Legionnaires' disease** - severe pneumonia, high fevers, diarrhea/abdominal pain

Diagnosis:
- Culture on charcoal yeast extract medium
- urinary antigen
- Does not gram stain well

Tx/Prevention:
- antibiotic must be concentrated inside mΦ
- atypical coverage - azithromycin, levofloxacin

Haemophilus influenzae

General:
- Transmission: respiratory route

- Most virulent strains are encapsulated -Typed (a, b, c, d, e, f) by capsule -Type b most invasive

- Requires blood medium to grow -uses NAD+ (V factor) in blood for metabolic activity -uses hematin (X factor) for cytochrome system

Pathophysiology:

Meningitis (children)
- inhaled > invades local lymph nodes > blood stream > infects meninges
> if treated with antibiotics, bacterial lysis leads to release of LPS lipid A (endotoxin) > violent immune responses that destroys neurons

Epiglottitis (children)
- cause rapid swelling of the epiglottis > obstruction of the airways

Pneumonia
- Patients with viral influenza infection or preexisting lung disease susceptible to getting H. flu pneumonia

Upper Respiratory Infection
- Nonencapsulated (nontypeable) strains colonize ears and upper respiratory tract > **otitis media**, bronchitis

Presentation:
Epiglottis: stridor, excessive saliva, cherry red epiglottis, + thumb sign on xray

Meningitis: fever, vomiting, altered mental status

Otitis media: ear pain, bulging tympanic membrane

Diagnosis:
- Culture on chocolate agar -Factor V (NAD+) -Factor X (hematin)

Tx/Prevention:
Hib capsule vaccine -conjugated to diphtheria toxoid

Moraxella

General:
- part of normal respiratory flora
- Cause pneumonia in patients with lung disease

Bordatella pertussis

General:
- Many virulence factors and exotoxins
- Transmission: aerosolized form

Pathophysiology:
Pertussis toxin inhibits Gi protein
> ↑cAMP > impaired phagocytosis

Presentation:
Whooping cough - bursts of non productive cough followed by inspiratory gasps through narrowed epiglottis.
- Patients can become hypoxemic during attacks and vomiting often follows
- Cough can last for a few months.

Diagnosis:
- PCR most sensitive
- Culture on Bordet-Gengou medium (potato, blood, and glycerol)

Tx/Prevention:
- **Pertussis vaccine (DTaP)**: acellular vaccine
- Tx: **macrolides**

Fastidious

Facultative intracellular

Brucella

General:
- commonly seen in meat-packing industry, farmer, or traveler consuming dairy products not in the US
- undulant fever: peaks at night and normal in the morning

Diagnosis:
small Gram neg coccobacillus, culture (in BSL3)

Transmission:
- Unpasteurized dairy
- Direct contact with infected animal meat
- very infectious in laboratory

Bartonella

B. henselae

General:
HIV patients are susceptible

Transmission:
Cat bite or scratch

Pathophysiology:
Infects regional lymph node but usually resolves within a few days

HIV patients - causes bacteremia, endocarditis, **bacillary angiomatosis** (proliferation of small blood vessels in the skin and other organs)

Presentation:
Cat-scratch disease:
- Enlarged lymph node
- Low-grade fever, malaise

Diagnosis:
Serology/PCR

Tx/Prevention:
Doxycycline

B. quitana

General:
Trench fever
-first seen in WWI
-five day intervals between febrile episodes

Transmission: Louse

Tx:
Doxycycline

Obligatory intracellular

Chlamydia trachomatis

General:
- need host ATP to grow
- unable to culture on nonliving media
- no peptidoglycan layer (β-lactams cannot target)
- very small, ~size of large viruses
- primarily infects eyes and genitals

Transmission:
- sexual contact
- vaginal delivery
- transfer of eye secretions

Pathophysiology:

Life cycle:
1. Elementary body - inert, infectious particle that can enter into cell
2. Reticulate body - inside host cell
-inhibits phagosome-lysosome fusion
-host cell releases elementary bodies to infect more cells

Pelvic Inflammatory Disease:
- travels upward from urethra > cervix
- if spreads to uterus, fallopian tubes, and ovaries > pelvic inflammatory disease (PID) + fallopian tube scarring
- can spread to liver capsule > **Fitz-Hugh-Curtis Syndrome**

Lymphogranuloma Venereum:
- ulcers on the genitals followed by migration to lymph nodes

Conjunctivitis:
- infection of the eyes

Reiter's Syndrome:
- infection of large joints

Presentation:
- **Nongonococcal urethritis** - asymptomatic, dysuria, mucoid discharge from urethra
- **Cervicitis** - inflamed, red cervix with yellow mucopurulent discharge, dyspareunia
- **PID** - uterine bleeding, lower abdominal pain, cervical motion tenderness -infertility, ↑risk for ectopic pregancy
- **Fitz-Hugh-Curtis Syndrome** - right upper quadrant pain
- **Lymphogranuloma Venereum** - painless papule on genitals that heals spontaneously, enlarging region lymph nodes that are tender and can break open
- **Conjunctivitis** - discharge, blindness
- **Reitar's Syndrome** - arthritis of large joints, commonly seen in young men

Diagnosis:
- gram stain - reveals neutrophils but does not take up gram
- PCR endocervical swab or urine

Tx/Prevention:
doxycycline
azithromycin

Rickettsiae

R. rickettsiae

General:
- small, intracellular organism
- require ATP to grow
- require arthropod vector
- dogs are reservoir
- found into southeastern US, Appalachian -Tennessee, North/South Carolina, Oklahoma
- Transmission: Tick bite

Pathophysiology:
Tick bite transmits R. Rickettsiae
> proliferate in the endothelial lining of capillaries
> hemorrhages and thrombi > **Rocky Mountain Spotted Fever**

Presentation:
Rocky Mountain Spotted Fever:
- fever, severe headache, rash, conjunctival redness
- Rash typically starts at wrist, ankles, soles, and palms and then spreads to trunk

Diagnosis:
Serology, PCR

Tx/Prevention:
- Early removal of tick
- Doxycycline

R. typhi

General:
- cause Endemic Typhus -fever, headache -maculopapular rash that starts centrally and spreads out, sparing palms and soles

- rodents are reservoir
- Tranmission: Flea bite

Tx:
Doxycycline

Coxiella burnetti

General:
- Does **not** live in arthropod vector
- forms endospore that allows it to survive outside host
- does not have arthropod transmission
- Grows in large, domesticated mammals
- Spores aerosolized > cause human disease
- Q-fever - abrupt onset of fever, soaking sweats with pneumonia

Tx:
Doxycycline

Cocci

Pseudomonad

Comma-shaped

Anaerobic

Small coccobacilli

Bacteroides

General:
- obligate anaerobe
- makes up majority of flora in intestinal tract
- also lives in mouth and vagina

Pathophysiology:
- causes abscesses in peritoneal cavity if there is a penetrating wound of the GI tract
- can lead to septic shock

Presentation:
- patient with bowel rupture

Tx/Prevention:
Metronidazole

Fusiform

Fusobacterium

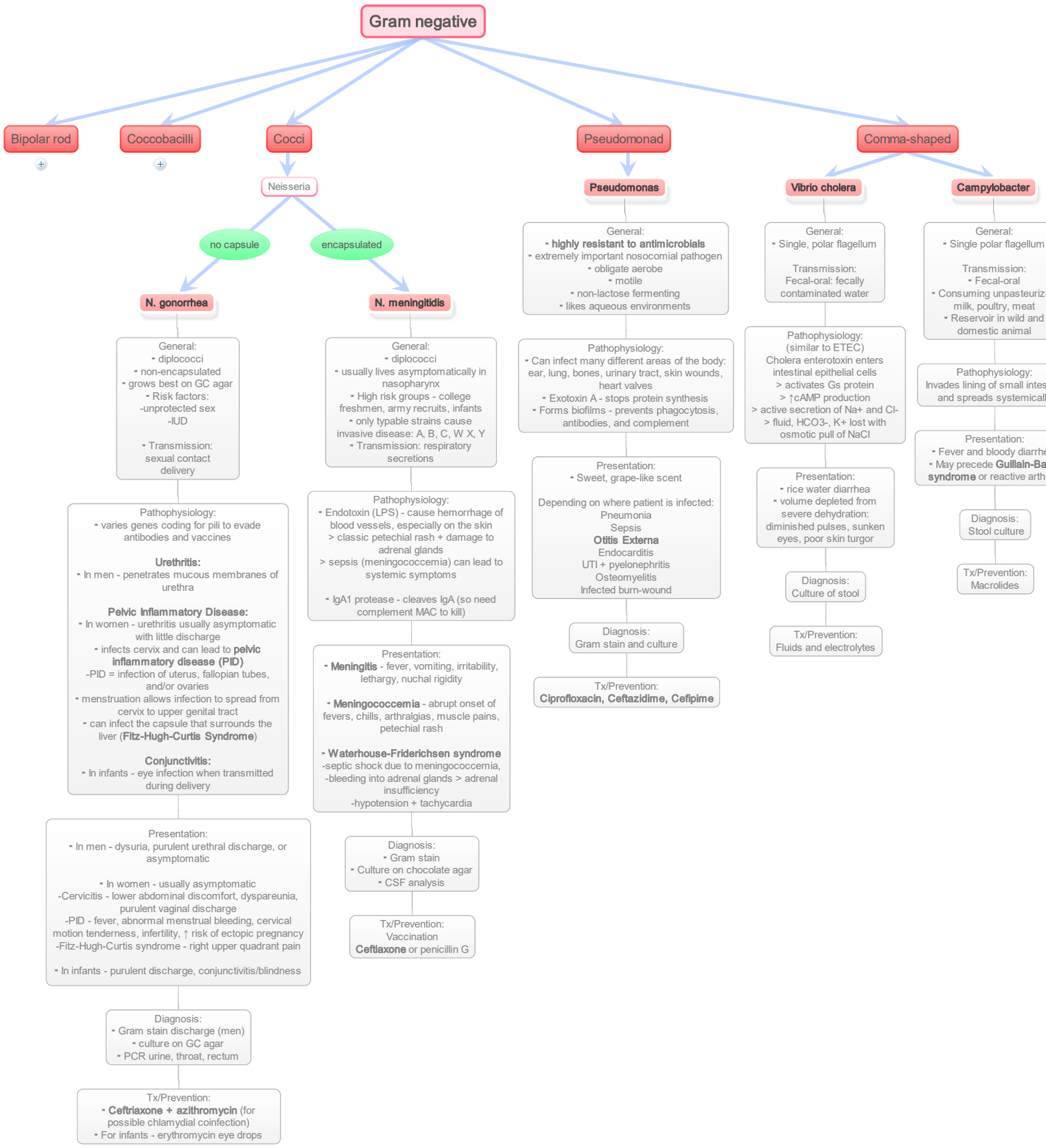
General:
- Anaerobic
- Found in oral cavity

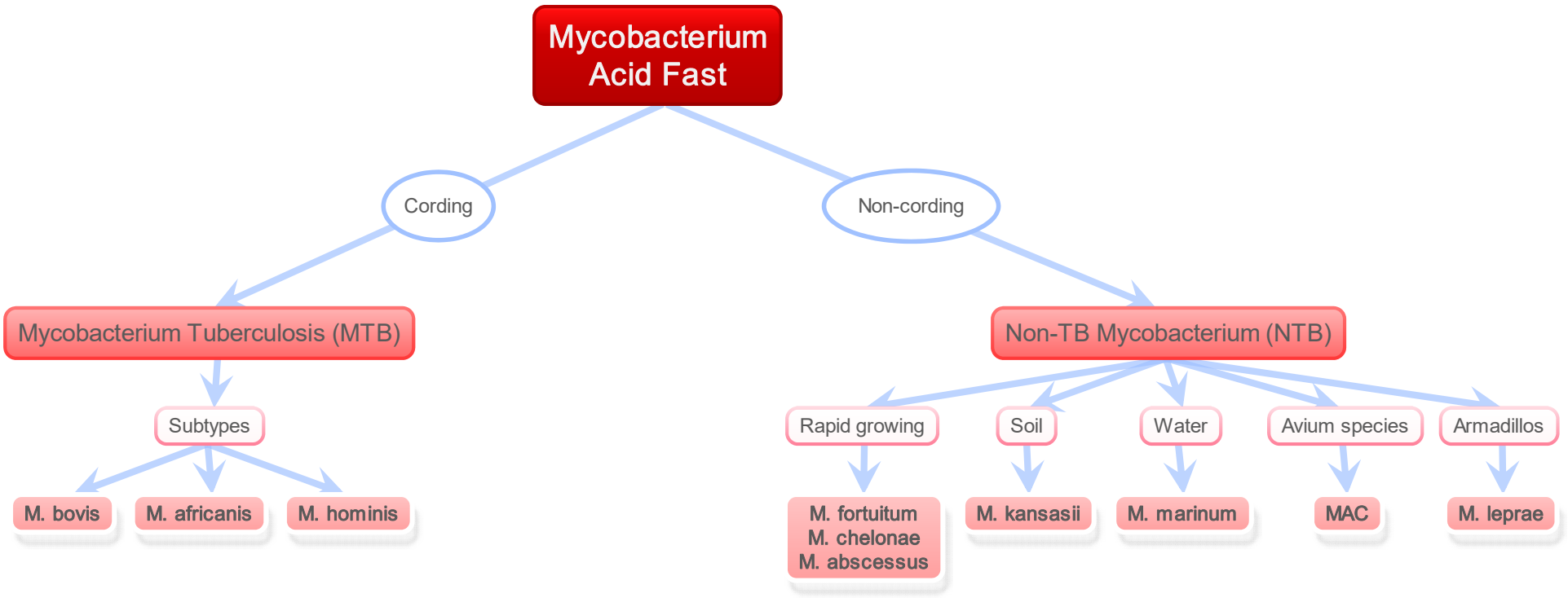
Pathophysiology:
- Causes peridontal disease and aspiration pneumonia

- Dental abscess in diabetic, alcoholic, or immunocompromised patient

Presentation:
Bad breath

Tx:
Clindamycin


Gram negative
Bipolar rod
Coccobacilli
Cocci
Pseudomonad
Comma-shaped
Neisseria
no capsule
encapsulated
Pseudomonas
Vibrio cholera
Campylobacter
N. gonorrhea
N. meningitidis
General:
- diplococci
- non-encapsulated
- grows best on GC agar
- Risk factors:
-unprotected sex
-IUD
- Transmission:
sexual contact
delivery
Pathophysiology:
- varies genes coding for pili to evade antibodies and vaccines
Urethritis:
- In men - penetrates mucous membranes of urethra
Pelvic Inflammatory Disease:
- In women - urethritis usually asymptomatic with little discharge
- infects cervix and can lead to pelvic inflammatory disease (PID)
-PID = infection of uterus, fallopian tubes, and/or ovaries
- menstruation allows infection to spread from cervix to upper genital tract
- can infect the capsule that surrounds the liver (Fitz-Hugh-Curtis Syndrome)
Conjunctivitis:
- In infants - eye infection when transmitted during delivery
Presentation:
- In men - dysuria, purulent urethral discharge, or asymptomatic
- In women - usually asymptomatic
-Cervicitis - lower abdominal discomfort, dyspareunia, purulent vaginal discharge
-PID - fever, abnormal menstrual bleeding, cervical motion tenderness, infertility, ↑ risk of ectopic pregnancy
-Fitz-Hugh-Curtis syndrome - right upper quadrant pain
- In infants - purulent discharge, conjunctivitis/blindness
Diagnosis:
- Gram stain discharge (men)
- culture on GC agar
- PCR urine, throat, rectum
Tx/Prevention:
- Ceftriaxone + azithromycin (for possible chlamydial coinfection)
- For infants - erythromycin eye drops
General:
- diplococci
- usually lives asymptomatically in nasopharynx
- High risk groups - college freshmen, army recruits, infants
- only typable strains cause invasive disease: A, B, C, W X, Y
- Transmission: respiratory secretions
Pathophysiology:
- Endotoxin (LPS) - cause hemorrhage of blood vessels, especially on the skin
> classic petechial rash + damage to adrenal glands
> sepsis (meningococcemia) can lead to systemic symptoms
- IgA1 protease - cleaves IgA (so need complement MAC to kill)
Presentation:
- Meningitis - fever, vomiting, irritability, lethargy, nuchal rigidity
- Meningococcemia - abrupt onset of fevers, chills, arthralgias, muscle pains, petechial rash
- Waterhouse-Friderichsen syndrome
-septic shock due to meningococcemia,
-bleeding into adrenal glands > adrenal insufficiency
-hypotension + tachycardia
Diagnosis:
- Gram stain
- Culture on chocolate agar
- CSF analysis
Tx/Prevention:
Vaccination
Ceftiaxone or penicillin G
General:
- highly resistant to antimicrobials
- extremely important nosocomial pathogen
- obligate aerobe
- motile
- non-lactose fermenting
- likes aqueous environments
Pathophysiology:
- Can infect many different areas of the body: ear, lung, bones, urinary tract, skin wounds, heart valves
- Exotoxin A - stops protein synthesis
- Forms biofilms - prevents phagocytosis, antibodies, and complement
Presentation:
- Sweet, grape-like scent
Depending on where patient is infected:
Pneumonia
Sepsis
Otitis Externa
Endocarditis
UTI + pyelonephritis
Osteomyelitis
Infected burn-wound
Diagnosis:
Gram stain and culture
Tx/Prevention:
Ciprofloxacin, Ceftazidime, Cefipime
General:
- Single, polar flagellum
Transmission:
Fecal-oral: fecally contaminated water
Pathophysiology:
(similar to ETEC)
Cholera enterotoxin enters intestinal epithelial cells
> activates Gs protein
> ↑cAMP production
> active secretion of Na+ and Cl-
> fluid, HCO3-, K+ lost with osmotic pull of NaCl
Presentation:
- rice water diarrhea
- volume depleted from severe dehydration: diminished pulses, sunken eyes, poor skin turgor
Diagnosis:
Culture of stool
Tx/Prevention:
Fluids and electrolytes
General:
- Single polar flagellum
Transmission:
- Fecal-oral
- Consuming unpasteurized milk, poultry, meat
- Reservoir in wild and domestic animal
Pathophysiology:
Invades lining of small intestine and spreads systemically
Presentation:
- Fever and bloody diarrhea.
- May precede Guillain-Barre syndrome or reactive arthritis
Diagnosis:
Stool culture
Tx/Prevention:
Macrolides


Mycobacterium
Acid Fast
Cording
Non-cording
Mycobacterium Tuberculosis (MTB)
Non-TB Mycobacterium (NTB)
Subtypes
Rapid growing
Soil
Water
Avium species
Armadillos
M. bovis
M. africanis
M. hominis
M. fortuitum
M. chelonae
M. abscessus
M. kansasii
M. marinum
MAC
M. leprae

Mycobacterium Acid Fast

Cording

Mycobacterium Tuberculosis (MTB)

General:
- high lipid content in cell wall > acid fast, difficult for antibiotics to penetrate
- **mycolic acid in cell wall**
- obligate aerobe
- facultative intracellular
- need T cell immunity to fight pathogen
- Transmission: inhalation

Pathophysiology:
Mycoside virulence factors:
- Cord factor - inhibits mΦ maturation
- sulfatides - inhibit phagosme-lysosome fusion

Acute phase:
1. Inhaled into lungs and causes local inflammation, usually in **lower lobes**
2. Phagocytosed and multiply in mΦ
3. Can either cause systemic disease (**Primary TB**) or gets walled off in **caseous granuloma** and remain dormant in mΦ
4. Primary TB can spread to lungs, kidney, bones, CNS, liver, etc.

Chronic phase (secondary TB):
1. If MTB dormant, can reactivate later in host
2. Lungs - infection reccurs in **upper lobes** (highest O2) > caseation and cavitation

Presentation:
- Fever, night sweats, weight loss, hemoptysis, swollen cervical lymph nodes

- **Pott's disease** - destruction of intervertebral discs + vertebral bodies
- **CNS involvement** - meningitis, granulomas in brain
- **Miliary TB** - tiny millet-seed granulomas disseminated all over the body

Diagnoses:
- **PPD skin test** or **gamma-interferon release assay** (blood test) - indicates exposure
- Chest x-ray
- Sputum acid fast stain
- Culture - faster growth (7 days) than solid media; PCR most sensitive

Tx/Prevention:
- **BCG vaccine** (not used in US)
-only prevents TB meningitis

- For active infection (RIPE):
Rifampin
Isoniazid
Pyrazinamide
Ethambutol

M. bovis

- Ingestion of unpasteurized milk causing infection of GI tract
- Infects wild animals: bison, elk, moose
- pyrazinamide resistant

M. africanis

- from Africa
- worse resistance patterns

M. hominis

- Ubiquitous, but cases are rare
- worse resistance patterns

Non-cording

Non-TB Mycobacterium (NTB)

Rapid growing

M. fortuitum
M. chelonae
M. abscessus

Outbreak from pedicures, tattoos

Soil

M. kansasii

Similar presentation to MTB, often are confused with one another

Water

M. marinum

Exposure to contaminated sea water
-aquarium owner
-angler

Avium species

MAC

General:
- common **opportunistic infection in AIDS patient** (CD4 < 100)

Presentation:
fever, weight loss, diarrhea, malaise, ↑ALP

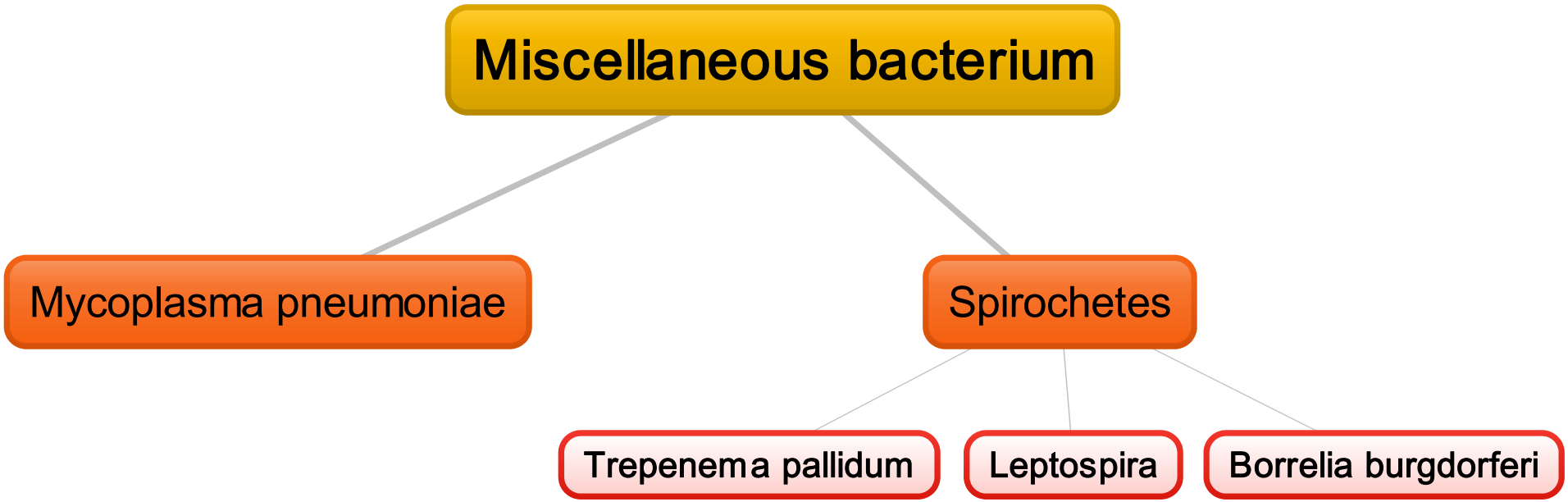
Diagnosis:
Blood culture

Tx/Prevention:
Azithromycin for prophylaxis

Armadillos

M. leprae

General:
Causes leprosy


Miscellaneous bacterium
Mycoplasma pneumoniae
Spirochetes
Trepenema pallidum
Leptospira
Borrelia burgdorferi

Miscellaneous bacterium

Mycoplasma pneumoniae

General:
- tiniest free living organism
- lack peptidoglycan wall (cannot use β-lactams)
- cell membrane contains cholesterol
- Transmission: inhalation

Pathophysiology:
After inhalation > attaches to respiratory epithelial cells
> 2-3 week incubation period > walking pneumonia

- patients can develop **cold agglutinins** (monoclonal IgM that bind to RBC causing them to agglutinate at 4ºC)

Presentation:
Walking pneumonia: fever, sore throat, malaise, persistent dry hacking cough

Diagnosis:
Cold agglutinin test - cool sample of patient's blood and check for agglutination

Tx/Prevention:
Doxycycline

Spirochetes
- gram negative
- corkscrew movements
- axial flagella

Trepenema pallidum

General:
- causes syphilis
- cannot be grown in laboratory
- Transmission: skin contact

Pathophysiology:
Penetrates intact mucous membranes by burrowing through tissue
> kills nerves so painless lesion
> can then move systemically
>infection occurs in 3 phases

1º syphilis: initial infection

2º syphilis: systemic spread

3º syphilis: slow inflammatory damage to multiple organs
-damage vasa vasorum (arteries supplying the heart)
-damage posterior columns and dorsal roots of spinal cord
-damage nerve cells of the brain > psychiatric symptoms
-rapid progression to 3º syphilis in 6 months with HIV

Presentation:

1º syphilis:
painless chancre at site of contact, highly infective
Heals after 4-6 weeks

2º syphilis:
Generalized lymphadenopathy, fever, weight loss
maculopapular rash - widespread involving palms and soles
condyloma latum - painless, wartlike lesion on genitals

3º syphilis:
Gummas- granulomas in skin and bones
Aortic aneurysm - due to damage of vasa vasorum
Tabes dorsalis: loss of all sensation (proprioception, vibratory, temp, pain) and reflexes
General paresis: mental deteriortaion and psychiatric symptoms
Argyll-Robertson pupil: midbrain lesion > pupils do not constrict to light but constricts for accommodation

Diagnosis:
- RPR/VDRL test:
-testing for antibodies against lipids that are released into the serum due to cellular damage
-non-specific tests that can be falsely positive
-titer useful to follow response to therapy

- EIA, TPPA (treponema pallidum particle agglutionation) test:
-tests for antibodies against Treponema
-more specific test

Tx/Prevention:
Penicillin G

Leptospira

General:
- found in the urine of animals
- Transmission: fresh water contamined with animal urine coming in contact with any mucosal membrane
- Weil's Disease: severe illness involving renal failure, hepatitis, meningoencephalitis, septic shock

Tx:
Doxycycline

Borrelia burgdorferi

General:
- causes lyme disease
- seen in Northeast
- Reservoir: deer, small rodents
- Arthropod vector: Ixodes tick

Pathophysiology:
Infection occurs in stages
- Early localized stage: lesion at site of bite
- Early disseminated stage: travels to heart, skin, nervous system, and joints
- Late stage: chronic arthritis

Presentation:

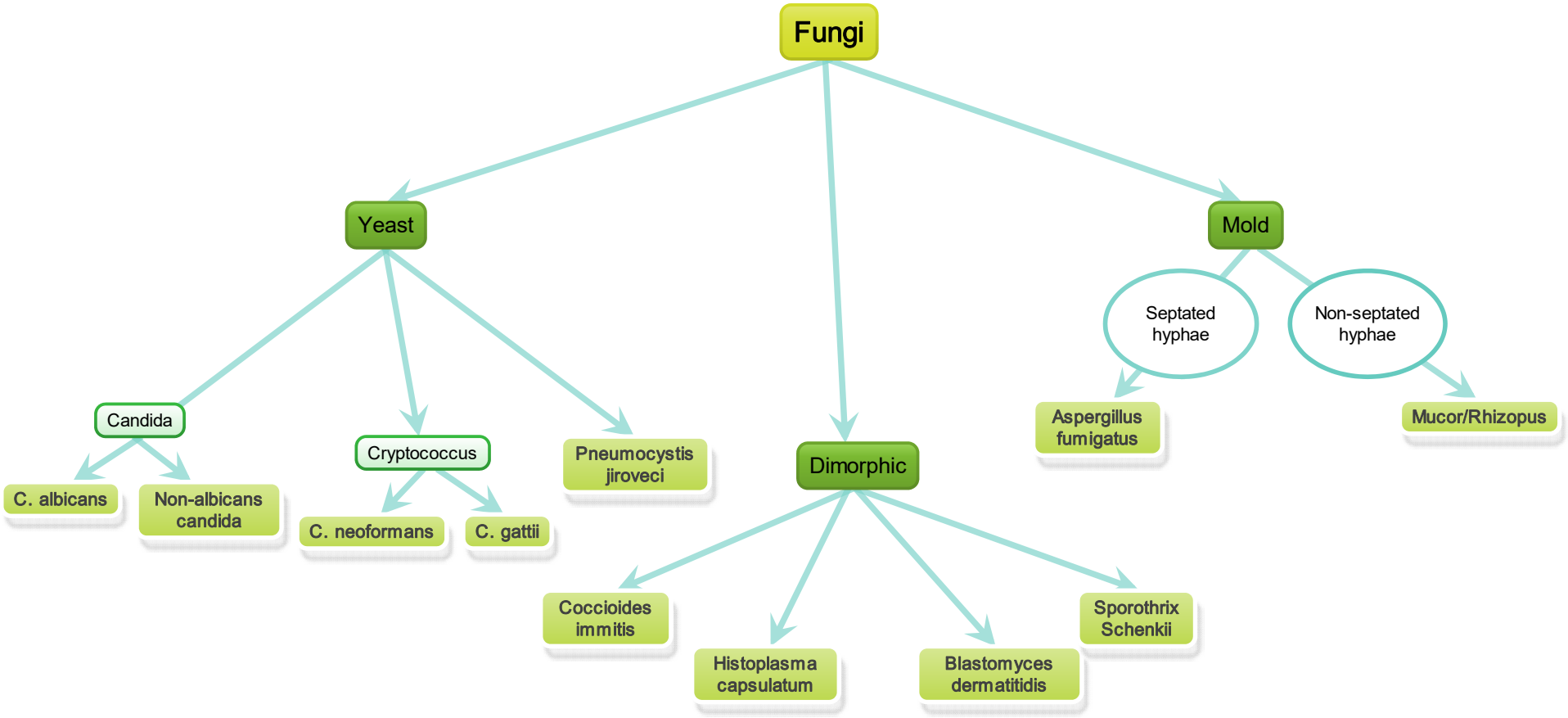
Early localized stage:
Erythema chronicum migrans - red, target-like lesion at site of tick bite

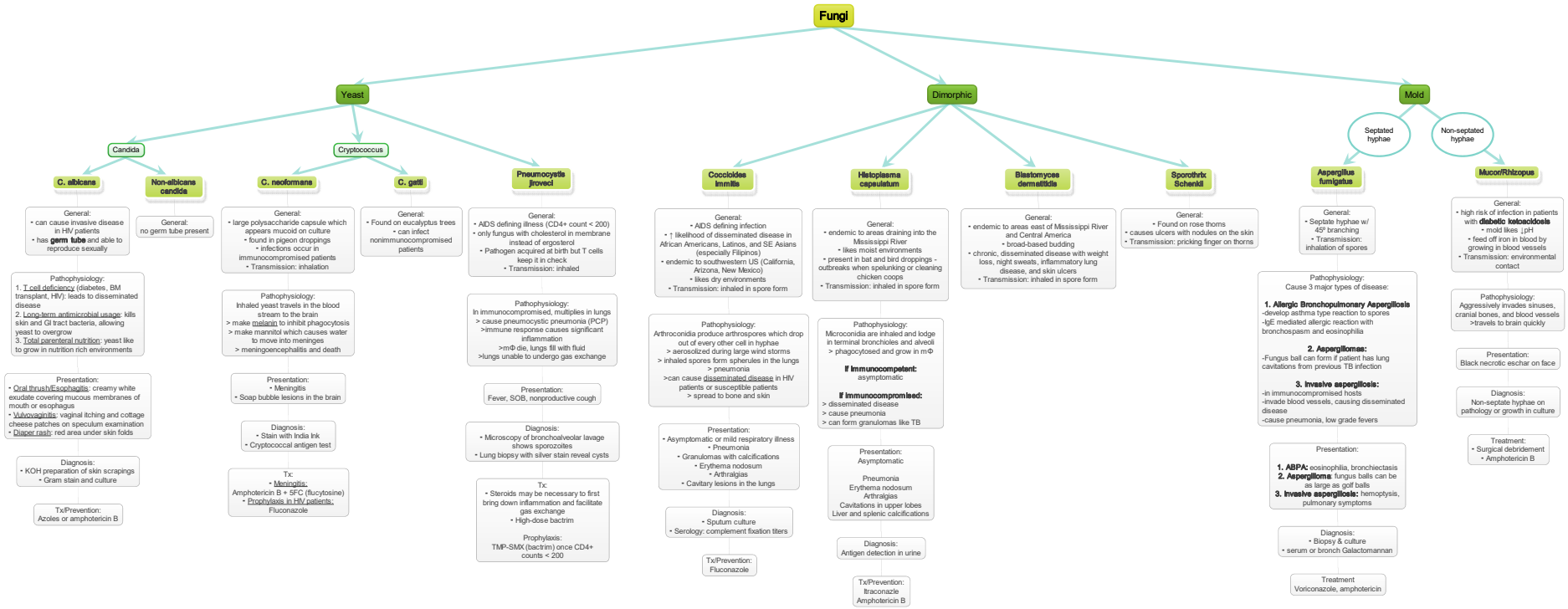
Early disseminated stage:
- CNS: facial palsy (bilateral), polyneuropathies
- Cardiac: AV heart block
- Migratory arthritis

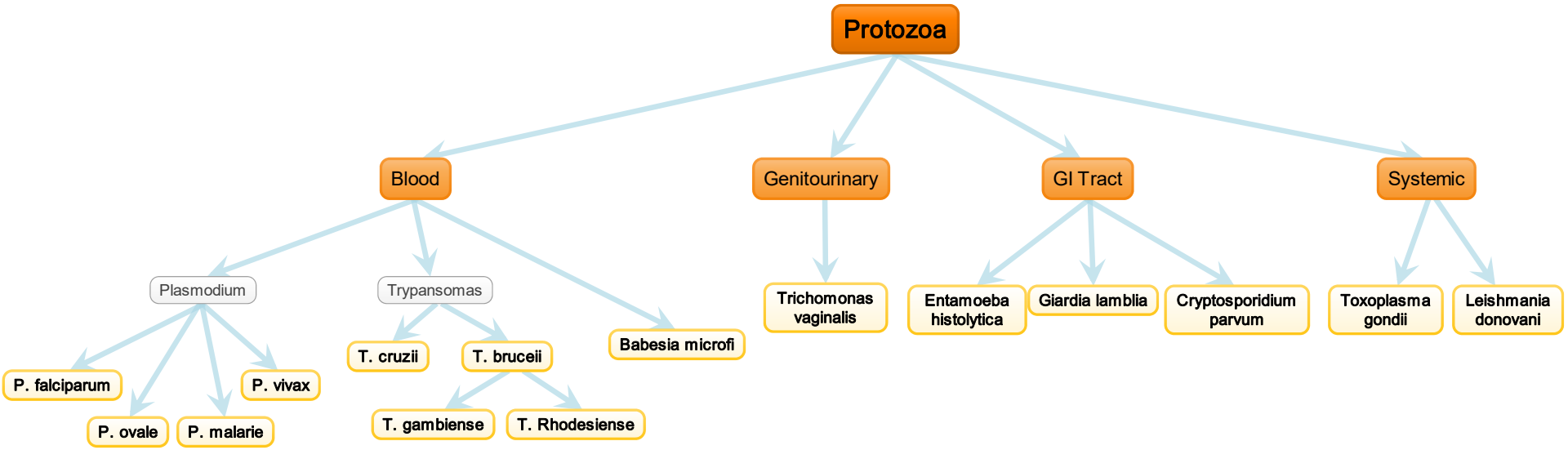
Late stage:
Chronic arthritis of large joints

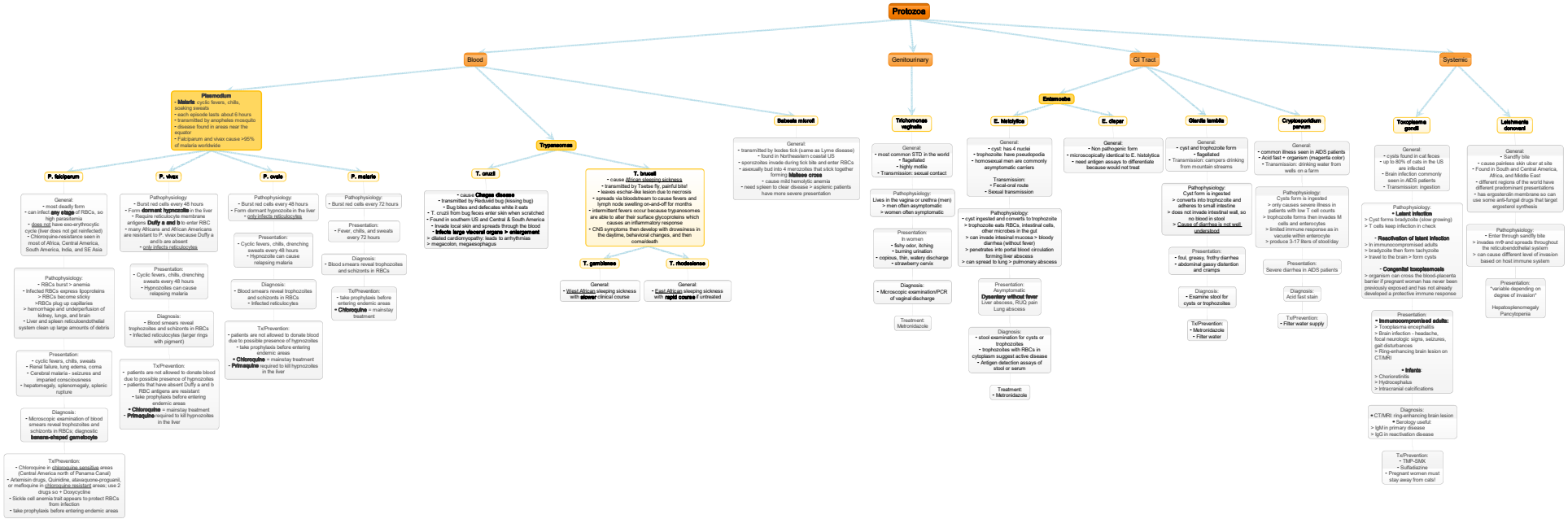
Diagnosis:
- Culture difficult
- Rely on clinical signs and serology

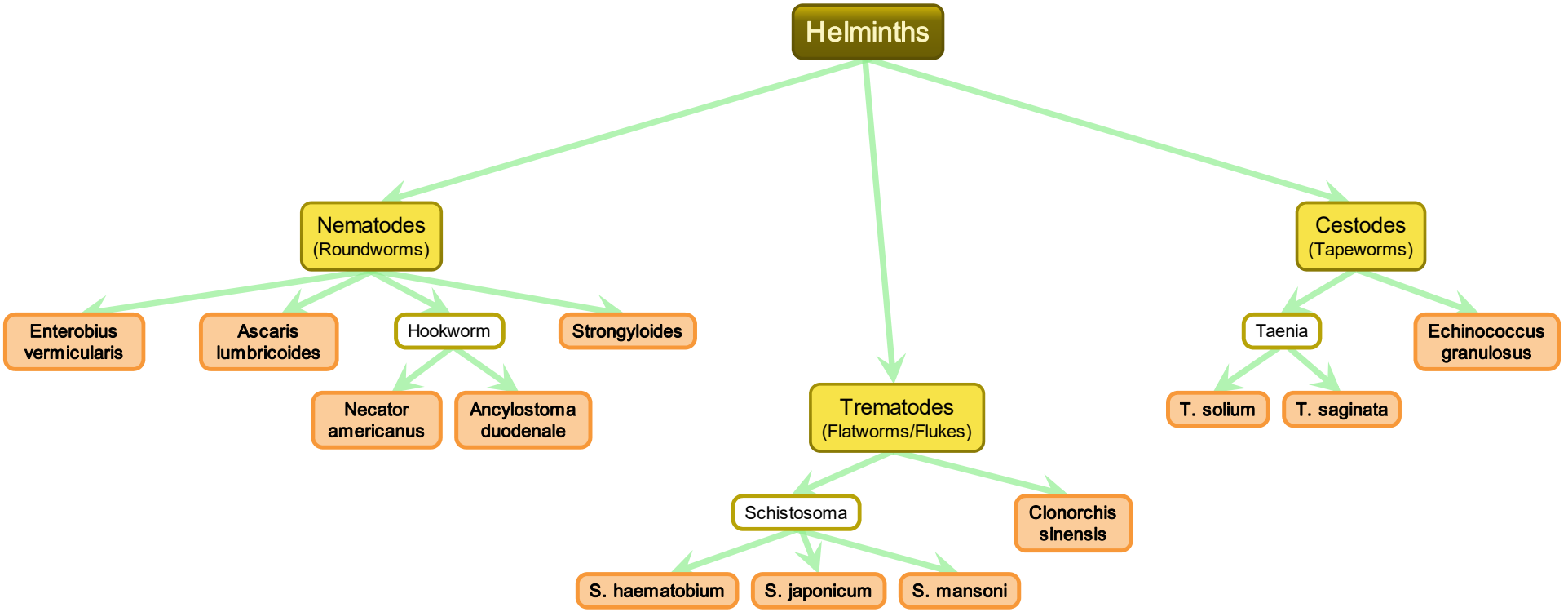
Tx/Prevention:
- Doxycycline
- Ceftriaxone for disseminated infection


Fungi
Yeast
Mold
Septated hyphae
Non-septated hyphae
Candida
Cryptococcus
Pneumocystis jiroveci
Dimorphic
Aspergillus fumigatus
Mucor/Rhizopus
C. albicans
Non-albicans candida
C. neoformans
C. gattii
Coccioides immitis
Histoplasma capsulatum
Blastomyces dermatitidis
Sporothrix Schenkii


Fungi
Yeast
Dimorphic
Mold
Candida
Cryptococcus
C. albicans
Non-albicans candida
C. neoformans
C. gatii
Pneumocystis jiroveci
General:
• can cause invasive disease in HIV patients
• has germ tube and able to reproduce sexually
General:
no germ tube present
General:
• large polysaccharide capsule which appears mucoid on culture
• found in pigeon droppings
• infections occur in immunocompromised patients
• Transmission: inhalation
General:
• Found on eucalyptus trees
• can infect nonimmunocompromised patients
General:
• AIDS defining illness (CD4+ count < 200)
• only fungus with cholesterol in membrane instead of ergosterol
• Pathogen acquired at birth but T cells keep it in check
• Transmission: inhaled
Pathophysiology:
1. T cell deficiency (diabetes, BM transplant, HIV): leads to disseminated disease
2. Long-term antimicrobial usage: kills skin and GI tract bacteria, allowing yeast to overgrow
3. Total parenteral nutrition: yeast like to grow in nutrition rich environments
Pathophysiology:
Inhaled yeast travels in the blood stream to the brain
> make melanin to inhibit phagocytosis
> make mannitol which causes water to move into meninges
> meningoencephalitis and death
Pathophysiology:
In immunocompromised, multiplies in lungs
> cause pneumocystic pneumonia (PCP)
>immune response causes significant inflammation
>mΦ die, lungs fill with fluid
>lungs unable to undergo gas exchange
Presentation:
• Oral thrush/Esophagitis: creamy white exudate covering mucous membranes of mouth or esophagus
• Vulvovaginitis: vaginal itching and cottage cheese patches on speculum examination
• Diaper rash: red area under skin folds
Presentation:
• Meningitis
• Soap bubble lesions in the brain
Presentation:
Fever, SOB, nonproductive cough
Diagnosis:
• KOH preparation of skin scrapings
• Gram stain and culture
Diagnosis:
• Stain with India Ink
• Cryptococcal antigen test
Diagnosis:
• Microscopy of bronchoalveolar lavage shows sporozoites
• Lung biopsy with silver stain reveal cysts
Tx/Prevention:
Azoles or amphotericin B
Tx:
• Meningitis:
Amphotericin B + 5FC (flucytosine)
• Prophylaxis in HIV patients:
Fluconazole
Tx:
• Steroids may be necessary to first bring down inflammation and facilitate gas exchange
• High-dose bactrim
Prophylaxis:
TMP-SMX (bactrim) once CD4+ counts < 200
Coccioides immitis
Histoplasma capsulatum
Blastomyces dermatitidis
Sporothrix Schenkii
General:
• AIDS defining infection
• ↑ likelihood of disseminated disease in African Americans, Latinos, and SE Asians (especially Filipinos)
• endemic to southwestern US (California, Arizona, New Mexico)
• likes dry environments
• Transmission: inhaled in spore form
General:
• endemic to areas draining into the Mississippi River
• likes moist environments
• present in bat and bird droppings - outbreaks when spelunking or cleaning chicken coops
• Transmission: inhaled in spore form
General:
• endemic to areas east of Mississippi River and Central America
• broad-based budding
• chronic, disseminated disease with weight loss, night sweats, inflammatory lung disease, and skin ulcers
• Transmission: inhaled in spore form
General:
• Found on rose thorns
• causes ulcers with nodules on the skin
• Transmission: pricking finger on thorns
Pathophysiology:
Arthroconidia produce arthrospores which drop out of every other cell in hyphae
> aerosolized during large wind storms
> inhaled spores form spherules in the lungs
> pneumonia
>can cause disseminated disease in HIV patients or susceptible patients
> spread to bone and skin
Pathophysiology:
Microconidia are inhaled and lodge in terminal bronchioles and alveoli
> phagocytosed and grow in mΦ
If immunocompetent:
asymptomatic
If immunocompromised:
> disseminated disease
> cause pneumonia
> can form granulomas like TB
Presentation:
• Asymptomatic or mild respiratory illness
• Pneumonia
• Granulomas with calcifications
• Erythema nodosum
• Arthralgias
• Cavitary lesions in the lungs
Presentation:
Asymptomatic
Pneumonia
Erythema nodosum
Arthralgias
Cavitations in upper lobes
Liver and splenic calcifications
Diagnosis:
• Sputum culture
• Serology: complement fixation titers
Diagnosis:
Antigen detection in urine
Tx/Prevention:
Fluconazole
Tx/Prevention:
Itraconazle
Amphotericin B
Septated hyphae
Non-septated hyphae
Aspergillus fumigatus
Mucor/Rhizopus
General:
• Septate hyphae w/ 45º branching
• Transmission: inhalation of spores
General:
• high risk of infection in patients with diabetic ketoacidosis
• mold likes ↓pH
• feed off iron in blood by growing in blood vessels
• Transmission: environmental contact
Pathophysiology:
Cause 3 major types of disease:
1. Allergic Bronchopulmonary Aspergillosis
-develop asthma type reaction to spores
-IgE mediated allergic reaction with bronchospasm and eosinophilia
2. Aspergillomas:
-Fungus ball can form if patient has lung cavitations from previous TB infection
3. Invasive aspergillosis:
-in immunocompromised hosts
-invade blood vessels, causing disseminated disease
-cause pneumonia, low grade fevers
Pathophysiology:
Aggressively invades sinuses, cranial bones, and blood vessels
>travels to brain quickly
Presentation:
1. ABPA: eosinophilia, bronchiectasis
2. Aspergilloma: fungus balls can be as large as golf balls
3. Invasive aspergillosis: hemoptysis, pulmonary symptoms
Presentation:
Black necrotic eschar on face
Diagnosis:
• Biopsy & culture
• serum or bronch Galactomannan
Diagnosis:
Non-septate hyphae on pathology or growth in culture
Treatment
Voriconazole, amphotericin
Treatment:
• Surgical debridement
• Amphotericin B


Protozoa
Blood
Genitourinary
GI Tract
Systemic
Plasmodium
Trypansomas
Babesia microfi
Trichomonas vaginalis
Entamoeba histolytica
Giardia lamblia
Cryptosporidium parvum
Toxoplasma gondii
Leishmania donovani
P. falciparum
P. ovale
P. malarie
P. vivax
T. cruzii
T. bruceii
T. gambiense
T. Rhodesiense


Protozoa
Blood
Genitourinary
GI Tract
Systemic
Plasmodium
- Malaria cyclic fevers, chills, soaking sweats
- each episode lasts about 6 hours
- transmitted by anopheles mosquito
- disease found in areas near the equator
- Falciparum and vivax cause >95% of malaria worldwide
P. falciparum
General:
- most deadly form
- can infect any stage of RBCs, so high parasitemia
- does not have exo-erythrocytic cycle (liver does not get reinfected)
- Chloroquine-resistance seen in most of Africa, Central America, South America, India, and SE Asia
Pathophysiology:
- RBCs burst > anemia
- Infected RBCs express lipoproteins > RBCs become sticky
>RBCs plug up capillaries
> hemorrhage and underperfusion of kidney, lungs, and brain
- Liver and spleen reticuloendothelial system clean up large amounts of debris
Presentation:
- cyclic fevers, chills, sweats
- Renal failure, lung edema, coma
- Cerebral malaria - seizures and impaired consciousness
- hepatomegaly, splenomegaly, splenic rupture
Diagnosis:
- Microscopic examination of blood smears reveal trophozoites and schizonts in RBCs; diagnostic banana-shaped gametocyte
Tx/Prevention:
- Chloroquine in chloroquine sensitive areas (Central America north of Panama Canal)
- Artemisin drugs, Quinoline, atavaquone-proguanil, or mefloquine in chloroquine resistant areas; use 2 drugs so: + Doxycycline
- Sickle cell anemia trait appears to protect RBCs from infection
- take prophylaxis before entering endemic areas
P. vivax
Pathophysiology:
- Burst red cells every 48 hours
- Form dormant hypnozoite in the liver
- Require reticulocyte membrane antigens Duffy a and b to enter RBC
- many Africans and African Americans are resistant to P. vivax because Duffy a and b are absent
- only infects reticulocytes
Presentation:
- Cyclic fevers, chills, drenching sweats every 48 hours
- Hypnozoites can cause relapsing malaria
Diagnosis:
- Blood smears reveal trophozoites and schizonts in RBCs
- Infected reticulocytes (larger rings with pigment)
Tx/Prevention:
- patients are not allowed to donate blood due to possible presence of hypnozoites
- patients that have absent Duffy a and b RBC antigens are resistant
- take prophylaxis before entering endemic areas
- Chloroquine + mainstay treatment
- Primaquine required to kill hypnozoites in the liver
P. ovale
Pathophysiology:
- Burst red cells every 48 hours
- Form dormant hypnozoite in the liver
- only infects reticulocytes
Presentation:
- Cyclic fevers, chills, drenching sweats every 48 hours
- Hypnozoite can cause relapsing malaria
Diagnosis:
- Blood smears reveal trophozoites and schizonts in RBCs
- Infected reticulocytes
Tx/Prevention:
- patients are not allowed to donate blood due to possible presence of hypnozoites
- take prophylaxis before entering endemic areas
- Chloroquine + mainstay treatment
- Primaquine required to kill hypnozoites in the liver
P. malaria
Pathophysiology:
- Burst red cells every 72 hours
Presentation:
- Fever, chills, and sweats every 72 hours
Diagnosis:
- Blood smears reveal trophozoites and schizonts in RBCs
Tx/Prevention:
- take prophylaxis before entering endemic areas
- Chloroquine + mainstay treatment
Trypanosomes
T. cruzi
- cause Chagas disease
- transmitted by Reduviid bug (kissing bug)
- Bug bites and defecates while it eats
- T. cruzi from bug feces enter skin when scratched
- Found in southern US and Central & South America
- invade local skin and spreads through the blood
- Infects large visceral organs > enlargement
> dilated cardiomyopathy: leads to arrhythmias
> megacolon, megaesophagus
T. brucei
- cause African sleeping sickness
- transmitted by Tsetse fly, painful bite!
- leaves eschar-like lesion due to necrosis
- spreads via bloodstream to cause fevers and lymph node swelling on-and-off for months
- intermittent fevers occur because trypanosomes are able to alter their surface glycoproteins which causes an inflammatory response
- CNS symptoms then develop with drowsiness in the daytime, behavioral changes, and then comaldeath
T. gambiense
General:
- West African sleeping sickness with slower clinical course
T. rhodesiense
General:
- East African sleeping sickness with rapid course if untreated
Babesia microti
General:
- transmitted by Ixodes tick (same as Lyme disease)
- found in Northeastern coastal US
- sporozoites invade during tick bite and enter RBCs
- asexually bud into 4 merozoites that stick together forming Maltese cross
- cause mild hemolytic anemia
- need spleen to clear disease > asplenic patients have more severe presentation
Trichomonas vaginalis
General:
- most common STD in the world
- flagellated
- highly motile
- Transmission: sexual contact
Pathophysiology:
Lives in the vagina or urethra (men)
> men often asymptomatic
> women often symptomatic
Presentation:
In women
- fishy odor, itching
- burning urination
- copious, thin, watery discharge
- strawberry cervix
Diagnosis:
- Microscopic examination/PCR of vaginal discharge
Treatment:
Metronidazole
Entamoeba
E. histolytica
General:
- cyst: has 4 nuclei
- trophozoite: have pseudopodia
- homosexual men are commonly asymptomatic carriers
Transmission:
- Fecal-oral route
- Sexual transmission
Pathophysiology:
- cyst ingested and converts to trophozoite
> trophozoite eats RBCs, intestinal cells, other microbes in the gut
> can invade intestinal mucosa > bloody diarrhea (without fever)
> penetrates into portal blood circulation forming liver abscess
> can spread to lung > pulmonary abscess
Presentation:
Asymptomatic
Dysentery without fever
Liver abscess, RUQ pain
Lung abscess
Diagnosis:
- stool examination for cysts or trophozoites
- trophozoites with RBCs in cytoplasm suggest active disease
- Antigen detection assays of stool or serum
Treatment:
- Metronidazole
E. dispar
General:
- Non pathogenic form
- microscopically identical to E. histolytica
- need antigen assays to differentiate because would not treat
Giardia lamblia
General:
- cyst and trophozoite form
- flagellated
Transmission: campers drinking from mountain streams
Pathophysiology:
Cyst form is ingested
> converts into trophozoite and adheres to small intestine
> does not invade intestinal wall, so no blood in stool
> Cause of diarrhea is not well understood
Presentation:
- foul, greasy, frothy diarrhea
- abdominal gassy distention and cramps
Diagnosis:
- Examine stool for cysts or trophozoites
Tx/Prevention:
- Metronidazole
- Filter water
Cryptosporidium parvum
General:
- common illness seen in AIDS patients
- Acid fast + organism (magenta color)
- Transmission: drinking water from wells on a farm
Pathophysiology:
Cysts form is ingested
> only causes severe illness in patients with low T cell counts
> trophozoite forms then invades M cells and enterocytes
> limited immune response as in vacuole within enterocyte
> produce 3-17 liters of stool/day
Presentation:
Severe diarrhea in AIDS patients
Diagnosis:
Acid fast stain
Tx/Prevention:
- Filter water supply
Toxoplasma gondii
General:
- cysts found in cat feces
- up to 80% of cats in the US are infected
- Brain infection commonly seen in AIDS patients
- Transmission: ingestion
Pathophysiology:
- Latent infection
> Cyst forms bradyzoite (slow growing)
> T cells keep infection in check
- Reactivation of latent infection
> In immunocompromised adults
> bradyzoite then form tachyzoite
> travel to the brain > form cysts
- Congenital toxoplasmosis
> organism can cross the blood-placenta barrier if pregnant woman has never been previously exposed and has not already developed a protective immune response
Presentation:
- Immunocompromised adults:
> Toxoplasma encephalitis
> Brain infection - headache, focal neurologic signs, seizures, gait disturbances
> Ring-enhancing brain lesion on CT/MRI
- Infants
> Chorioretinitis
> Hydrocephalus
> Intracranial calcifications
Diagnosis:
- CT/MRI: ring-enhancing brain lesion
- Serology useful:
> IgM in primary disease
> IgG in reactivation disease
Tx/Prevention:
- TMP-SMX
- Sulfadiazine
- Pregnant women must stay away from cats!
Leishmania donovani
General:
- Sandfly bite
- cause painless skin ulcer at site
- Found in South and Central America, Africa, and Middle East
- different regions of the world have different predominant presentations
- has ergosterolin membrane so can use some anti-fungal drugs that target ergosterol synthesis
Pathophysiology:
- Enter through sandfly bite
> invades mΦ and spreads throughout the reticuloendothelial system
> can cause different level of invasion based on host immune system
Presentation:
variable depending on degree of invasion
Hepatosplenomegaly
Pancytopenia


Helminths
Nematodes
(Roundworms)
Cestodes
(Tapeworms)
Trematodes
(Flatworms/Flukes)
Enterobius vermicularis
Ascaris lumbricoides
Hookworm
Strongyloides
Necator americanus
Ancylostoma duodenale
Taenia
Echinococcus granulosus
T. solium
T. saginata
Schistosoma
Clonorchis sinensis
S. haematobium
S. japonicum
S. mansoni

Helminths

Nematodes (Roundworms)

Enterobius vermicularis

General:
- also known as pinworm
- Transmission: fecal-oral

Pathophysiology:
- Eggs are ingested
> mature in the large intestine
> at night, females migrates to perianal area to lay eggs
> hatch a few hours later >
intense itching
- scratching allows for host to reinfect themself or others

Presentation:
- perianal itching, especially at night
- no eosinophilia because no tissue invasion

Diagnosis:
- scotch tape test: tape placed in perianal region at night

Treatment:
- **Mebendazole**

Ascaris lumbricoides

General:
- affects over 1 billion people
- can grow up to 1 meter long
- Transmission: contaminated food
- Can cause invasive disease b/c of developmental cycle

Pathophysiology:
- Eggs are ingested
> larvae emerge in the small intestine
> burrow through intestinal wall and travel in the blood stream to the lungs
> grow in alveoli until coughed up and swallowed
> reach small intestine and grow by consuming food in the GI tract
> adults lay eggs which are then excreted in the feces
- High worm load, can lead to swelling + twisting of intestine

Presentation:
- **Asymptomatic**
> Pulmonary infiltrates
> High eosinophil count

- **High worm load**:
> Malnutition
> Intussusception or volvulus of intestine
> Necrosis of bowel

Diagnosis:
Identify eggs in feces

Tx/Prevention:
- Treat acute infection with mebendazole or limit worm burden in endemic areas with yearly therapy

Hookworm

Necator americanus

General:
- Transmission: contact with soil

Pathophysiology:
- Larvae lives in soil
> transforms and able to penetrate human skin
> travels to alveoli and grow
> move to small intestine
> attach to wall with pincers and suck blood
> sexually reproduce - release fertilized eggs in feces

Presentation:
- diarrhea, abdominal pain, weight loss
- Iron deficiency anemia
- Eosinophilia

Diagnosis:
Identify eggs in fecal sample

Tx/Prevention:
Bendazoles
Wear shoes at the beach in developing countries!

Ancylostoma duodenale

General:
- similar to Necator americanus but with more blood loss

Strongyloides

General:
- potentially lethal disease in immunocompromised
- seen in any tropical area

Pathophysiology:
- larvae grows in soil
> penetrate human skin
> travels to the lungs
> coughed up and swallowed
> travels to the small intestine + lays eggs
> hatched larvae can penetrate intestine and travel to the lungs to continue cycle

- Immunosuppressive agents can cause disseminated disease in infected individuals

- When penetrating gut wall, can bring gut bacteria along with it
> see gram (-) infections in the CNS

Presentation:
- Vomitng, abdominal bloating, diarrhea, anemia
- Pruritic rash, lung symptoms
- Eosinophilia

Diagnosis:
Identify larvae in feces
Eosinophilia

Treatment:
- **Ivermectin**

Trematodes (Flatworms/Flukes)

Schistosoma
Life cycle:
1. Eggs hatch in freshwater and infect freshwater snail
2.. Released to infect humans swimming in freshwater through exposed skin
3. Travel to intrahepatic portion of portal system
4. Schistosomes mature and mate
5. Pairs will migrate either to veins around intestine or bladder (depending on species)
6. Lay eggs which are excreted through feces or urine

Clinical Manifestations
Many of the eggs that the schistosomes pairs lay do not reach the feces or urine
> flow in bloodstream to deposit in liver, lung, or brain
> cause inflammatory response + fibrosis/granuloma formation
> can get stuck in blood vessels > fibrosis > occlusion
> cirrhosis of the liver/hepatocellular carcinoma

Diagnosis:
>Identify eggs in the stool or urine
>Differentiate between species based on spine location on egg

Tx:
Praziquantel

S. haematobium

General:
- Found in Africa
- egg has **terminal spine**
- resides in veins around **bladder**
- deposits eggs in urine
- can lead to squamous cell carcinoma of the bladder with painless hematuria
- pulmonary hypertension

S. japonicum

General:
- found in Eastern Asia
- egg **does not have spine**
- resides in veins around **intestine**
- deposits eggs in feces

S. mansoni

General:
- Found in South America and Africa
- egg has **lateral spine**
- resides in veins around **intestine**
- deposits eggs in feces

Clonorchis sinensis

General:
- from ingesting undercooked fish
- seen in SE Asia

Pathophysiology:
Fluke travels to the biliary tract
> cause large abscess in liver or biliary tree
> relapsing cholangitis > choloangiocarcinoma
> produce eggs that are passed in stool

Presentation:
- Pigmented gallstones
- Cholangiocarcinoma

Diagnosis:
Identify eggs in stool

Tx/Prevention:
Praziquantel

Cestodes (Tapeworms)

Taenia

T. solium

General:
- pork tapeworm
- eating undercooked pork infected with larvae or eggs or from food workers that don't wash hands
- causes different pathologies depending on whether larvae or egg forms are ingested
- can grow to 2-8 meters
- hermaphroditic

Pathophysiology:

- Larvae encysted in undercooked pork is ingested:
> larvae attaches to mucosa of intestine via hooklets
> releases eggs in feces
> minimal symptoms

- Cysticercosis:
> ingest eggs instead of hatched larvae
> eggs hatch in small intestine
> larvae travel throughout the body
> penetrate tissues and encyst
> particularly likes to encyst in brain and SKM

Presentation:
- Asymptomatic
- Cysticercosis: calcified cysticerci
- Neurocysticercosis: cysts in the brain > seizures, obstructive hydrocephalus, focal deficits

Diagnosis:
- Eggs in fecal sample
- CT scan or biopsy of infected tissue

Tx/Prevention:
- Albendazole + steroids for cysticercosis
- Praziquantel for intestinal

T. saginata

General:
- beef tapeworm
- only causes disease when larvae form is ingested

Pathophysiology:
- same lifecycle as T.solium
- no development of cysticerci so infection considered benign

Presentation:
- malnutrition and weight loss

Diagnosis:
Identify eggs in feces

Tx/Prevention:
Praziquantel

Echinococcus granulosus

General:
- ingestion of eggs from dog feces

Pathophysiology:
Eggs are ingested and larvae hatch in intestine:
> penetrate intestinal wall and disseminate throughout body
> most go to liver; some to lungs, kidney, brain
> larve form fluid-filled hydatid cyst that undergo asexual budding
> humans highly allergic to fluid within cysts, allergic rxn to cyst bursts may be fatal

Presentation:
- Anaphylaxis from cyst burst
- Compression of organ based on location of cyst

Diagnosis:
- CT scan for cysts
- Tissue biopsy

Tx:
- **Albendazole**
- +Surgical removal

Viruses

Herpes Virus
- all DNA viruses
- Has particular cell it lays dormant in

- HHV 1 = HSV 1
- HHV 2 = HSV 2
- HHV 3 = VZV

- HHV 4 = EBV
- HHV 5 = CMV
- HHV 6 = Roseola
- HHV 7 = Roseola
- HHV 8

HSV 1: Herpes simplex 1
- acquired through sexual contact or kissing
- usually infects mucosal-integument border
- associated with oral mucosa

Pathophysiology:
- Dormant cell: cell body of neuron
- reactivation at original site of infection during time of stress
- local tissue destruction > painful ulcers

Can cause **herpes encephalitis:**
- travels from CN V to specific brain regions > hemorrhagic necrosis
-temporal lobes (auditory)
-amygdala (memory loss)
-hippocampus
-fever, RBCs in CSF

Dx: culture, PCR, serology

Tx: acyclovir, valacyclovir

HSV 2: Herpes simplex 2
- acquire through sexual contact
- usually infects mucosal-integument border
- associated with genital mucosa

Pathophysiology:
- Dormant cell: cell body of neuron
- reactivation at original site of infection during time of stress
- local tissue destruction > painful ulcers

Dx: culture, PCR, serology

Tx: acyclovir, valacyclovir

VZV: Varicella zoster
- inhaled pathogen
- present with lesions at different stages of development (as opposed to small pox)
- can occur on the eye, inside the ear

Pathophysiology:
- Dormant cell: all the cell bodies within a ganglion
- Reactivation within a particular dermatome

Vaccine:
- Zoster vaccine: for younger patients
- Shingle vaccine for older patients

Tx: acyclovir, valacyclovir

EBV: Epstein Barr Virus
- direct contact - kissing, sharing drinks

Pathophysiology:
- enters oral pharynx > lymphoid tissue (tonsils)
- infects B cells and causes massive proliferation
- Causes **Mono**: lymphadenopathy, malaise, low grade fever
- T cells fight off infection, but virus remains dormant in B cells

Lymphoma:
- In the future, if infected B cell multiplies > lots of replication errors
- mutated B cells can develop into lymphoma

Tx: no good antivirals

CMV: Cytomegalovirus
- direct contact - kissing, sharing drinks

Pathophysiology:
- Dormant cell: monocytes and endothelium
- can cause especially large giant cells

In immuno-compromised patients
- only causes disease when ↓T cells
- CMV starts to pour out of monocytes an endothelial cells
- innate immune system starts to destroy endothelial cells
- vasculitis > end organ damage
- HIV patients: see end organ damage commonly in colon and retina (vision loss)

Dx: culture, viral loads

Tx: ganciclovir, foscarnet

HHV8:
- direct contact

Pathphysiology:
- Dormant cell: monocytes and endothelium
- Enter into the genome causing mutations and uncontrolled growth
- disease typically seen in immunocompromised patients
- Causes angiosarcoma (cancer of blood vessel)

Kaposi Sarcoma
- purple, shiny lesions on the skin
- can cause bleeding into compartments of the body

Tx: antiretrovirals, local therapy tx, chemotherapy if significant lesions

Hepatitis
- viruses are not in one family
- grouped because they all cause hepatitis

Hep A: fecal oral, vaccine
Hep B: body fluid, vaccine, the only DNA virus
Hep C: body fluid
Hep D: body fluid, needs coinfection w/ Hep B
Hep E: fecal oral, lethal in pregnant women

Hepatitis B:
- only one that is a DNA virus
- enveloped virus
- very infective (much more infective than HIV or Hep C)

Antigens
- clearing virus depends on whether or not immune system can recognize the antigens
- S protein: surface
- C protein: core
- E protein: enzymes

Pathophysiology:
- Acute phase
- Window phase
- Chronic phase

Dx: serology, PCR;

Tx: Antivirals

Hepatitis C:
- chronic process > destruction of hepatocytes
- can either progress to hepatocellular carcinoma or cirrhosis
- IL-28R: allele of receptor determines how well patient will clear infection given treatment (C allele better chance than T allele)

Dx: serology, viral loads

Tx: cure rate >90% with proteinase inhibitors and polymerase inhibitors

HIV

General:
- RNA virus, enveloped
- Glycoprotein 120 and 41 on the surface
- Infects CD4 T cells

Pathophysiology:

1. Fusion:
- Glycoprotein 120 and 4 binds to CCR5 on the CD4 T cell
- Cell membranes fuse together, allowing entry

2. Reverse transcription
- reverse transcriptase: transcribes RNA into looped DNA
- looped DNA can then become dsDNA
- Targeted by: NNRTI

3. Integration:
- Integrase: integrates dsDNA into host genome
- Targeted by: Integrase inhibitor

4. Transcribed RNA proteins
- Protease: cleaves peptide chain to form active protein
- Targeted by: protease inhibitor

Common infections based on CD4 counts:
≥ 200: TB, Candida, viral
< 200: AIDS dx, pneumocystis, cryptococcus
< 150: toxoplasma, histoplasma, HHV8 Kaposi sarcoma
< 100: cryptosporidium, MAC
< 50: CMV

Diagnosis:
- RNA PCR:
-measures viral load
-can detect within days
-main method of diagnosis

- Antibody response:
-test if body has produced antibody against HIV

- CD4 counts used to follow patients longterm!

Respiratory Viruses

Orthomyxovirus
Paramyxovirus
Respiratory Syncytial Virus (RSV)
Metapneumovirus

Orthomyxovirus: Influenza
- RNA virus, protein coat
- enveloped
- originally in water fowl, their domestication > infection of farm animals and humans
- surface proteins H (hemagglutinin) and N (neuraminidase) are assigned #'s based on their composition (ex. H1N1)
- Influenza Type A and Influenza Type B

Pathophysiology:
- virus can mutate within each organism it infects
- Drift: virus changes its own genetic material
- Shift: two viruses exchange genetic material
- Influenza typically causes death because of secondary bacterial infection of the lungs

Tx:
- Amantadine - only works on type A
- Oseltamivir - works on A and B

GI/Neuro Viruses

Fecal oral viruses:
Enterovirus (Coxsackie)
Poliovirus
Norovirus
Rotavirus

Coxsackie Virus:
- pericarditis

Poliovirus:
- infects the cell bodies of the lower motor neurons within the spinal cord
- paralysis occurs
- dystrophy of muscles
- if infects C3-C5, used to cause respiratory paralysis

Non-endemic areas:
- killed vaccine

Endemic areas:
- need live vaccine because need to develop stronger immune response, but will shed live vaccine

Norovirus:
- cause fever, watery diarrhea 24-48 hours after infection
- associated with cruise ships, barracks, trains, or travel to another country

Rotovirus:
- cause watery diarrhea 24-28 hours after infection
- affects children, seen in day care centers

Neuro Viruses

West Nile Virus
Rabies

West Nile Virus:
- Arbovirus, spead by mosquitos through birds
- fever, chills
- encephalitic symptoms > coma
- usually affects elderly patients in the summertime

Rabies:
- neurovirus that lives in salivary glands of animals
- Bat is most commonly infected animal

Pathophysiology:
- Bite > virus enters and finds closest neuron
- causes local destruction at the cell body
- begins to moves toward the head
- further the bite, the better the prognosis

Presentation:
- hydrophobia
- dry mouth with copious saliva dripping out
- Negri bodies: found in nerve cells containing virus

Tx: do everything possible
- vaccinate patient
- try to find the animal responsible for the bite