



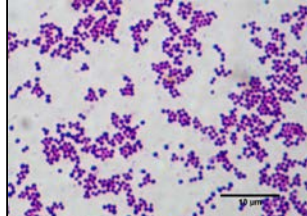
sketchy**micro**
flashcards

bacteria



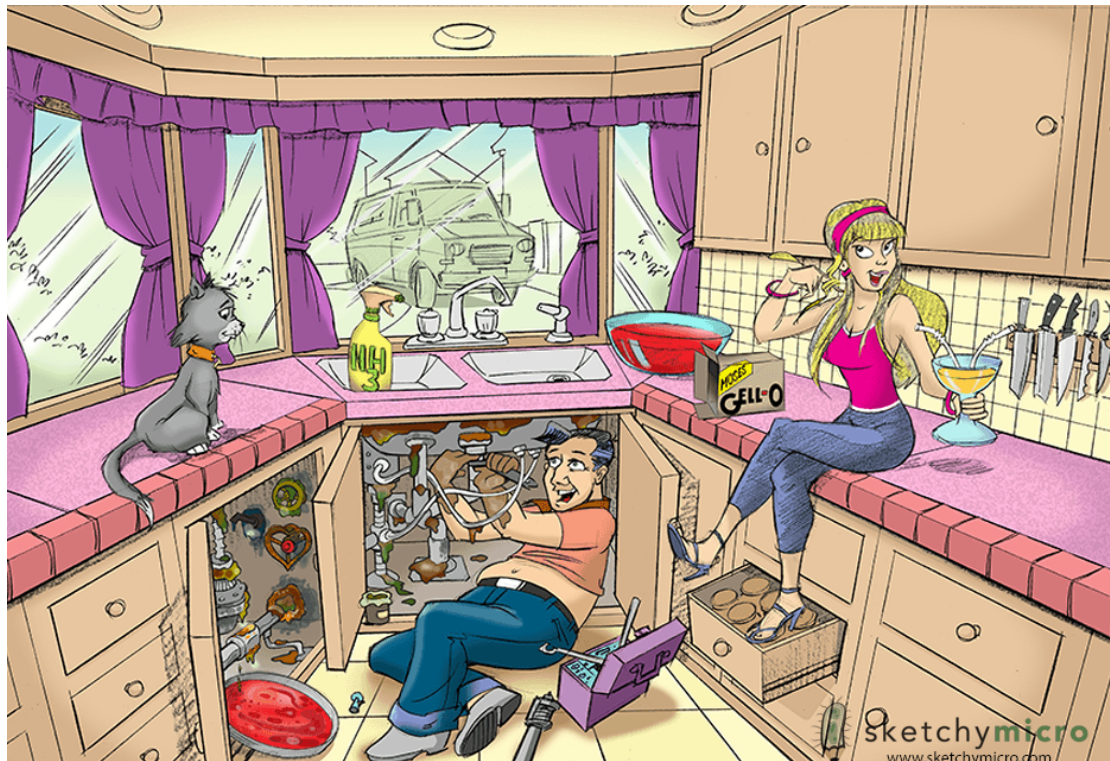
STAPHYLOCOCCUS AUREUS “Golden Staff of Moses”

- **Genus Features:** Gram+ (“Moses wearing violet robe”), cocci in clusters, catalase+ (“cat”), small, yellow colonies on blood agar, Beta-hemolytic (“bright light with Beta”), Coagulase+ (“blood red sea parting”), Ferments mannitol on mannitol salt agar (“Tall-man with yellow clothes”)
- **Reservoir:** Normal flora – nasal mucosa; 25% of population are carriers (“Sphinx’s nose in the foreground”), and skin
- **Transmission:** hands, sneezing, surgical wounds, contaminated foods – i.e. custard pastries, potato salad, canned meats (“meats and mayonnaise left out too long hanging from camel with nauseous woman”)
- **Predisposing Factors for Infection:** surgery/ wounds, foreign body – tampons, surgical packing, sutures – severe neutropenia, IV drug abuse, chronic granulomatous disease, Cystic Fibrosis
- **Disease and Pathogenesis:**
 - Protein A binds Fc component of IgG, inhibits phagocytosis = “Moses’ staff with ‘A’ binding to antibody at Fc”



Diseases	Clinical Symptoms	Pathogenicity
Gastroenteritis (food poisoning) – toxin is ingested preformed in the food = “woman clutching mouth on camel with spoiled foods hanging”	2-6 hours after ingesting toxin: nausea, abdominal pain, vomiting, followed by diarrhea = “rapid onset represented by running camel”	Enterotoxins A-E preformed in food, are fast acting and heat stable
Acute Infective Endocarditis, usually a result of IV drug abuse = “woman clutching heart sitting on hearts blanket on a running camel with mortar and pestle and vials”	Typically a right-sided heart infection of tricuspid valve (“behind woman are 3 pyramids”); fever, malaise, leukocytosis, heart murmur (may be absent initially)	Fibrin platelet mesh, cytolytic (alpha) toxins: Panton-Valentine leucocidin (PVL), forms pores in infected cells and is acquired by bacteriophage
Toxic Shock Syndrome = “bald man with super cape with lightning bolt”	Fever, hypotension, scarlatiniform rash that desquamates (esp. on palms and soles), multi-organ failure	TSST-1: a superantigen toxin, has nonspecific binding of MHC class II and t-cell receptors causing over-activation and eventual cytokine storm
Osteomyelitis (most common cause) = “bony fish in front of camel with bandages on knees”	Bone pain, fever, tissue swelling, redness; lytic bone lesions on imaging	Cytolysin toxin and coagulase+; converts fibrinogen to fibrin clot – forms localized boils, etc.
Pneumonia; staph is not the leading cause, but acquired if individual is already sick with virus = “man and camel on knees coughing, patchy blanket to represent patchy infiltrates, icosahedrals hanging to represent post-viral infection”	Productive pneumonia with rapid onset, high rate of necrosis, and high fatality; nosocomial, ventilator, postinfluenza, IV drug abuse, CF, CGD, etc. Salmon colored sputum.	
Abscesses and mastitis = “kneeling camel with humps covered in red cloths”	Subcutaneous tenderness, redness and swelling, hot	
Impetigo, Scalded Skin syndrome = “bald guy getting sunburned”	Erythematous papules to bullae; diffuse epidermal peeling	Coagulase and exfoliatins: skin-exfoliating toxins
Surgical Infections from wound packing	Fever with cellulitis and/or abscesses	Coagulase, exfoliatins, TSSTs

- **Treatment:** Gastroenteritis is self-limiting; Penicillin (“pharaoh’s pencil staff”) – Nafcillin/ oxacillin are DOC because of widespread antibiotic resistance; for methicillin-resistant *S. aureus* (MRSA) – vancomycin (“pharaoh with hand out showing mercy next to a caravan”), MRSA acquires its resistance by altering its penicillin-binding protein (“Anubis represent altered humans and they are rebuilding the pyramids”), for vancomycin-resistant *S. aureus* (VRSA) or vancomycin-intermediate *S. aureus* (VISA) – quinupristin/dalfopristin

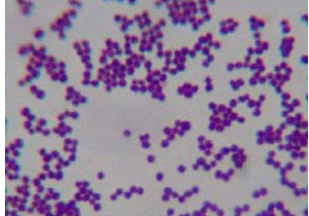


GENUS: STAPHYLOCOCCUS

“Beauty and the Plumber”

SPECIES: EPIDERMIDIS AND SAPROPHYTICUS

- **Genus features:** gram+ (“violet window curtains and countertops”), catalase+ (“cat”), coagulase- (“Moses’ Gell-O with red hyphen and smooth red jello”), **gamma-hemolysis/ no hemolysis**

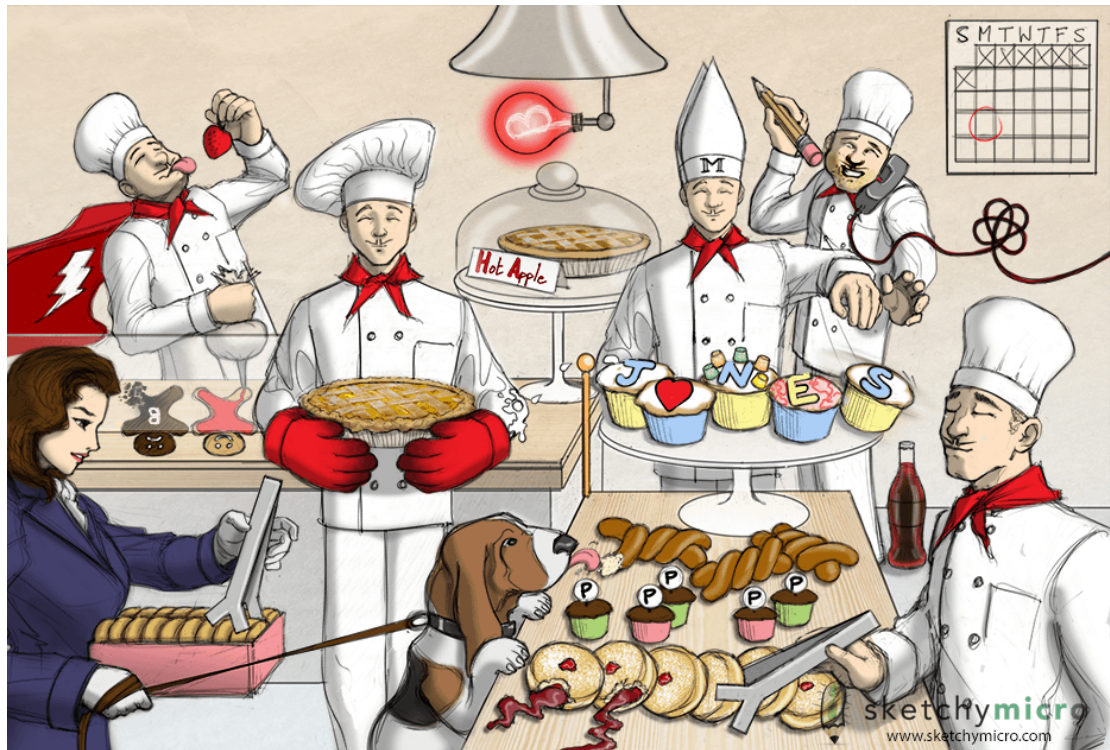


Staphylococcus epidermis = “represented by plumber and his activities”

- **Distinguishing Feature:** **Novobiocin-sensitive** (“navel – belly button exposed and sensitive on plumber”); **biofilm producer** (“gunk under the sink coating all the pipes, tubes, and valves”)
- **Reservoir:** **normal skin flora** (“dirt covering plumber’s arms”), **can contaminate blood cultures** (“leaking pipe onto blood culture plate”)
- **Disease Presentations:** **Endocarditis of artificial heart valves in IV drug users** (“heart-shaped valve”), **catheter infection** (“tubing under the sink”), and **prosthetic device infections** (“plumber working on the plumbing”)
- **Treatment:** **vancomycin** = “vanco van outside window”

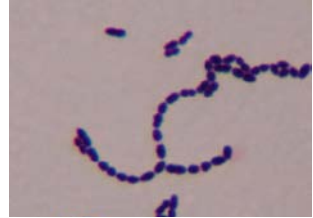
Staphylococcus saprophyticus = “represented by lady on the sink”

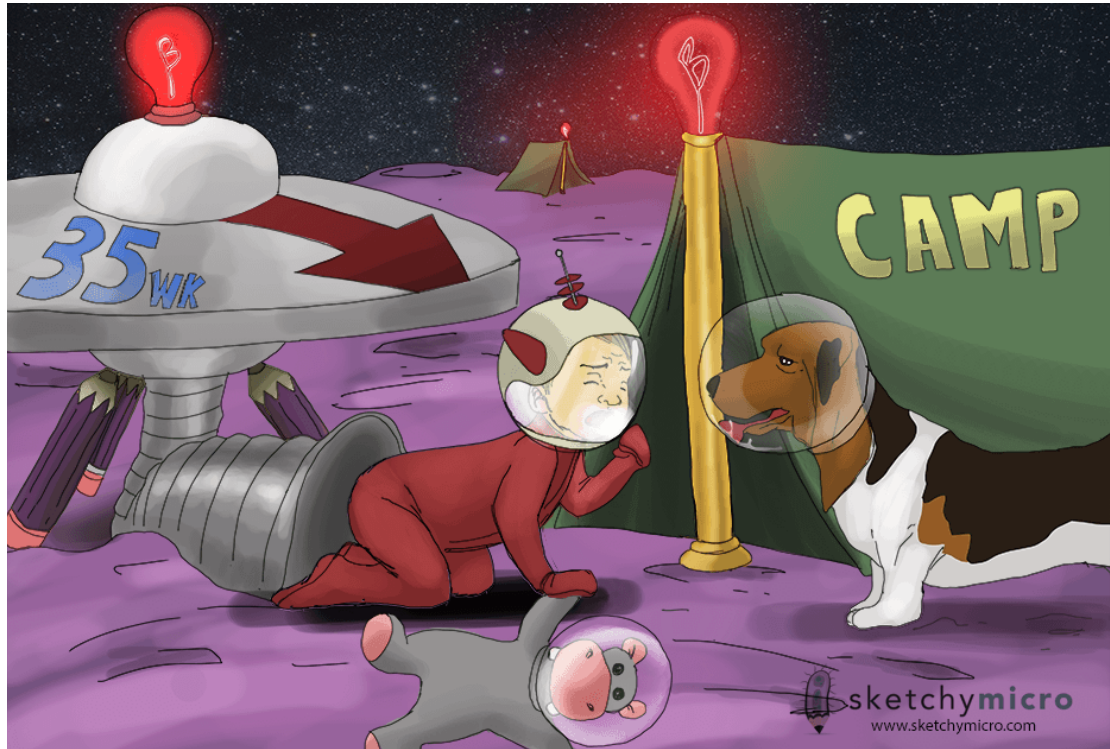
- **Distinguishing Feature:** **Novobiocin-resistant** (“belly button is not exposed”)
- **Disease Presentation:** **UTIs in newly sexually active females** = “young, sexy girl holding a yellow drink in glass shaped like a bladder with two straws representing ureters”



STREPTOCOCCUS PYOGENES (GROUP A) "THE PIE GENIES' BAKERY"

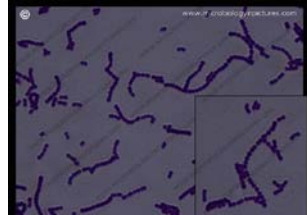
- **General features:** gram+ cocci in chains, catalase-, beta-hemolytic ("beta-light bulb heating lamp over pie"), **encapsulated with hyaluronic acid capsule** ("glass case over Hot Apple pie"), **bacitracin sensitive** ("basset hound able to eat the treats"), **pyrrolidonyl arylamidase (PYR)+**
- **Reservoir:** human throat, skin
- **Transmission:** direct contact, respiratory droplets
- **Pathogenesis:** Hyaluronic acid is non-immunogenic and hydrolyzes the ground substances of connective tissues, **M-protein of cell wall carbohydrates is antiphagocytic** ("master chef wearing an 'M' hat is swatting away the baker trying to eat his cupcakes"), **streptolysin O is immunogenic, hemolysin/ cytolysin** ("O-shaped donuts on counter leaking as if lysed"), **streptolysin S is not immunogenic, hemolysin/ cytolysin**
- **Spreading Factors:** **streptokinase** breaks down fibrin clot ("little muffins with P phosphates"), **streptococcal DNase liquefies pus**, **extends lesions** ("represented by twist breads"), **streptococcal pyrogenic exotoxins A and C are phage-coded** (i.e. cells are lysogenized by a phage) and cause fever and rash of scarlet fever; **B causes necrotizing fasciitis**
- **Diseases:**
 - **Pyoderma/ Impetigo** – symptoms of pyogenic skin infection with honey-crusted lesions = "baker holding lemon-crusted lemon-pie"
 - **Pharyngitis/ Strep Throat** – symptoms of abrupt onset of sore throat, fever, malaise, headache; tonsillar abscesses and tender anterior cervical lymph nodes = "bakers wearing red handkerchiefs around necks"
 - **Cellulitis/ Erysipelas** – erythema of skin = "baker wearing big red mittens"
 - **Scarlet Fever** – symptoms of pharyngitis followed by a blanching "sandpaper" rash with palms and soles and face usually spared ("gingerbread man on counter with red frosting covering most of body"), **circumoral pallor, strawberry tongue** ("baker with tongue out about to lick strawberry"), **and nausea and vomiting.**
 - **Toxic Shock-Like Syndrome and Necrotizing Fasciitis** – **superantigen invades fascia under the skin and spreads very rapidly; becomes a medical emergency and amputations are common** = "baker wearing super cape with lightning bolt with a burnt gingerbread man with leg amputated and "B" for exotoxin superantigen causing disease"
 - **Rheumatic Fever** – a sequelae of pharyngitis 2 weeks after infection; in a **type II hypersensitivity**, the **M protein virulence factor mimics the myosin in our hearts causing our own antibodies to attack the heart, specifically the mitral valve** ("Master chef wearing miter hat"), other symptoms of RF categorized by **JONES pneumonic**
 - **J = joints/ polyarthritis** ("baker pumping into J cupcake now with frosting on elbow"), **O in shape of heart = heart problems of valve-defect, myocarditis, pericarditis** ("heart shaped O"), **N = nodules, subcutaneous, that appear on extensor surface of forearm, elbows, and knees** ("candies on cupcake"), **E = erythema marginatum, a rash with red borders** ("frosting on cupcake to look like rash"), **S = Sydenham's chorea of rapid involuntary movements of the hands and face** ("cupcake falling")
 - **Acute Glomerulonephritis** – a sequelae of pharyngitis and impetigo skin infection ("red handkerchief and honey-crusted crumbs on face of baker"), **occurs 2 weeks after infection** ("calendar with circle two weeks after current date"); a **type III hypersensitivity where immune complexes bind to the glomerulus** ("baker talking on telephone with cord twisted in shape of glomerulus"), **causes edema** ("baker has puffy cheeks") and **hypertension**, as well as "smoky, cola-colored" urine ("cola-bottle by baker's feet")
- **Laboratory Diagnosis:** **rapid strep test (ELISA-based) misses approx. 25% of infections; culture all negatives. Antibodies to streptolysin O (ASO) titer of >200 is significant for RF** = ("lady buying box of donut O's checking them with antibody tongs)
- **Treatment:** **Penicillin**, although it doesn't protect from glomerulonephritis = "chef with PSGN holding the pencil"; **macrolides** used in penicillin allergy
- **Prevention:** **Prophylactic antibiotics** should be considered in patients for at least 5 years post-acute RF; **beta lactams (penicillin) and macrolides**





STREPTOCOCCUS AGALACTIAE (GROUP B) “A Galactic Baby”

- **General Features:** Gram+ (“violet planet backdrop”), catalase-, Beta-hemolytic (“Beta light bulbs on tents”), bacitracin resistant (“basset hound wearing a helmet, unable to lick baby”), hydrolyzes hippurate (“baby is holding stuffed hippo”), encapsulated (“hippo is wearing glass helmet”), CAMP test positive; CAMP factor is a polypeptide that complements the sphingomyelinase of *S. aureus* to create an enhanced hemolytic pattern in the shape of an arrow head (“space camp of tents with golden staff poles to refer back to Moses’ staph aureus’ staff”; “mother space shape represents a plate with arrow-head zone of hemolysis”)
- **Reservoir:** human vagina – 15-20% of women (“mother ship with tunnel that looks like vaginal canal”), and GI tract
- **Transmission:** newborns are infected during birth – increased risk with prolonged labor after rupture of membranes = “baby emerging from vaginal canal of mother ship”
- **Diseases:** neonatal septicemia (“baby wearing red clothing”) and meningitis (“meningitis space helmet on baby’s head”), and pneumonia (“baby is coughing”)
- **Treatment:** ampicillin with an aminoglycoside or a cephalosporin
- **Prevention:** Prophylaxis during delivery in women with a positive vaginal or rectal culture of GBS taken at 35 weeks of pregnancy (“35 wk on mother space ship”), also given with a history of recent infection with GBS, or prolonged labors after membrane rupture; ampicillin or penicillin are DOC (“pencil-shaped landing legs stabbing the mother ship”), Clindamycin or erythromycin for penicillin allergies





GENUS: STREPTOCOCCUS “The alpha knight tournament”

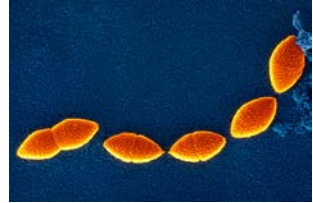
SPECIES: PNEUMONIAE AND VIRIDANS

Streptococcus pneumoniae:

- **Distinguishing features:** Gram+, catalase-, **alpha hemolytic** (“alpha sign in green, turns a green hue”), **encapsulated** (“Sir pneumo uno wearing full armor”), **optochin sensitive** (“knight’s chin is exposed”), **lancet-shaped diplococci** (“knight holding two lances”), **bile-soluble** (“knight’s horse stuck in the mud”)
- **Reservoir:** human upper respiratory tract
- **Transmission:** respiratory droplets – not considered highly communicable, often colonizes the nasopharynx without causing disease
- **Predisposing factors:** antecedent influenza or measles infection, COPD, CHF, alcoholism, asplenia – as in sickle cell disease – predisposes to septicemia (“knight has sickle hanging from waist”)
- **Pathogenesis:** polysaccharide capsule is major virulence factor, **IgA protease** (“knight carrying shield with IgA dimer molecule symbol”), **teichoic acid**, **pneumolysin O** (hemolysin/ cytotoxin – damages the respiratory epithelium and inhibits leukocyte respiratory burst and inhibits classical complement fixation)
- **Diseases:** MOPS pneumonic (“knight’s squire holding a mop”), *S. pneumoniae* is #1 cause for each (“fan holding #1 sign”)
 - M = meningitis in adults; peptidoglycan and teichoic acids are highly inflammatory in the CNS; CSF reveals high WBCs (neutrophils) and low glucose, high protein; O = otitis media in children; P = Pneumonia in adults, especially in 6th decade of life; presents with shaking chills, high fever, lobar consolidation, blood-tinged, “rusty” sputum (“knight’s chest armor with rust”); S = sinusitis in children
- **Laboratory Diagnosis:** gram stain and PCR of CSF, Quellung reaction is positive (no longer used but tested, swelling of capsule with addition of type-specific antiserum), and Latex particle agglutination test is positive for capsular antigen in CSF
- **Treatment:** macrolides like erythromycin (“crow perched”) for pneumonia; ceftriaxone or cefotaxime (“tri-axe symbol on flag”) for adult meningitis; vancomycin is added if penicillin-resistant; amoxicillin or erythromycin for otitis media and sinusitis in children
- **Prevention:** vaccines available – adult’s is a 23-valent polysaccharide that produces an IgM response; children’s is a 7-valent polysaccharide that produces an IgG response (“sign indicating adults sit in Mezzanine and children on Ground”)

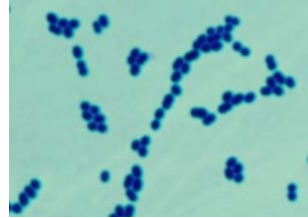
Streptococcus Viridans (*S. sanguis*, *S. mutans*)

- **Distinguishing features:** Gram+, catalase-, **alpha hemolytic** (“jester in green suit”), **non-encapsulated** (“Jester not wearing armor”), **optochin resistant** (“jester wearing mask with pointy chin for protection”), **bile-resistant** (“jester’s donkey with bile-resistant shoes not stuck in mud”)
- **Reservoir:** human oropharynx (normal flora)
- **Transmission:** endogenous
- **Diseases:** Dental carries (“donkey with terribly yellow teeth”) – *S. mutans* dextran-mediated adherence glues oral flora on teeth, forming plaque (“jester holding a deck of cards – dextran – and a plate for platelet adherence”); and Infective endocarditis with symptoms of malaise, anorexia, night sweats, weight loss, splinter hemorrhages – predisposing conditions include damaged or prosthetic heart valve, typically mitral valve (“jester wearing miter hat”), and dental work without prophylactic antibiotics or extremely poor oral hygiene; vegetation protects organism from immune system
- **Treatment:** penicillin G with aminoglycosides for endocarditis
- **Prevention:** prophylactic antibiotics prior to dental work for individuals with damaged heart valve





GENUS: ENTEROCOCCUS (Group D Strep) “Protest at the Caucus”
SPECIES: FAECALIS (“crowd in California, more common”) **AND FAECIUM**
 (“buff dude holding ‘Stop the Fees’ sign, more dangerous”)



- **General features:** gram+, catalase-, PYR+, cocci in chains, hydrolyze esculin in 40% bile – bile resistant (“buff dude unaffected by billy club by cop” and “bile-resistant boots”), and in 6.5% NaCl – bile esculin agar turns black (“crowd holding ‘resist the 6.5% N.CA’ sign”)
- **Reservoir:** human colon, urethra, female genital tract
- **Transmission:** endogenous
- **Pathogenesis and Diseases:** (“represented by ‘Do U <3 Trees’ sign”)
 - Bile/ salt tolerance allows survival in bowel and gall bladder, leads to urinary and biliary tract infections (“U = urinary tract infections; Trees = biliary tree infections”)
 - During medical procedures on GI or GU tract, *E. faecalis* enters bloodstream and goes to previously damaged heart valves, leading to infective endocarditis (“<3 symbol”)
- **Diagnosis:** Culture on blood agar, antibiotic sensitivities
- **Treatment:** all strains carry some drug resistance; some vancomycin-resistant *E. faecium* or *E. faecalis* (VRES) (“buff dude resisting arrest and entering the vanco van”) have no reliably effective treatment; In general for low-level resistance, use ampicillin, gentamicin, or streptomycin. Linezolid (“police caution line tape”) or Tigecycline (“police tape with tiger stripes”) can also be used instead. VanA strains have UPD-N-Acetylmuramyl pentapeptide with the terminal d-alanyl-d-alanine replaced with d-alanyl-d-lactate, which functions in cell wall synthesis but does not bind to vancomycin
- **Prevention:** prophylactic use of penicillin and gentamicin in patients with damaged heart valves prior to intestinal or urinary tract manipulations



GENUS: BACILLUS “King Anthra’s Axe”

SPECIES: ANTHRACIS AND CEREUS

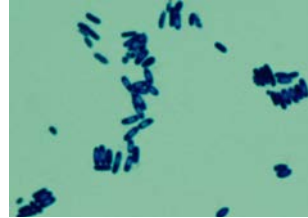
- **General features:** Gram+ rods, spore-forming (“walnuts roasting on fire”), **Aerobic** (“air bellow for the fire”)

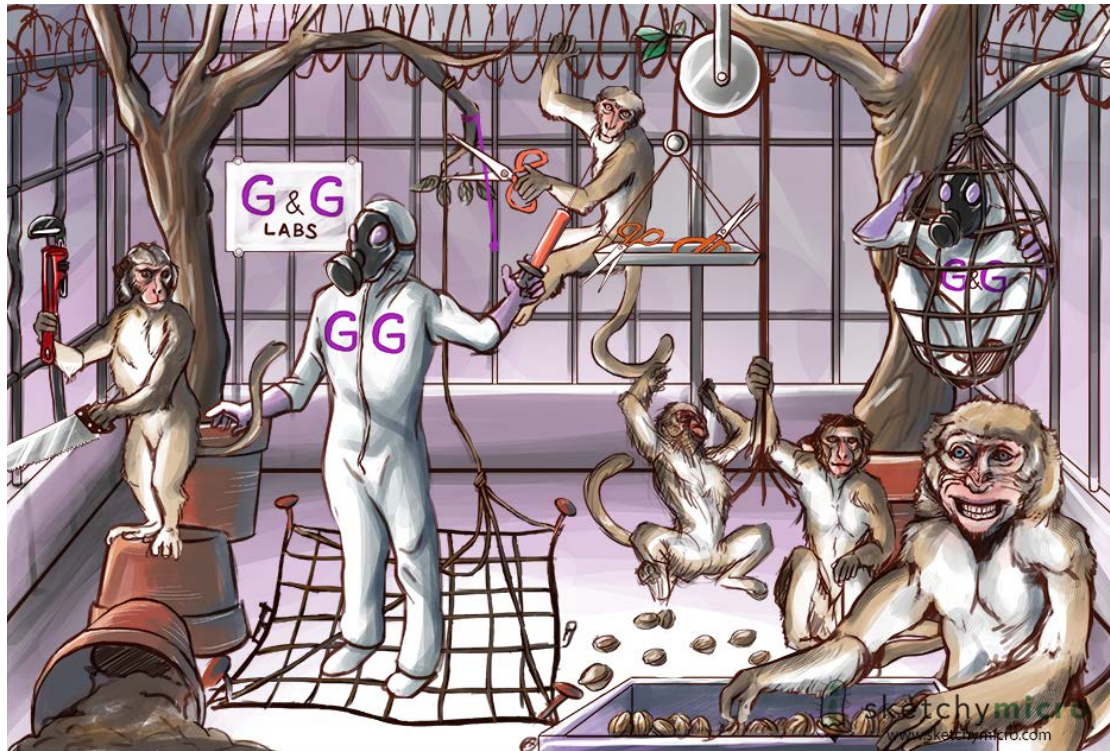
Bacillus anthracis

- **Distinguishing Features:** large, boxcar-like (“chain of Viking boats”), **poly-d-glutamate capsule** (“armor made of leathery protein and Vikings wearing multiple D-belts”), **potential biowarfare agent**
- **Reservoir:** animals, skins, soils
- **Transmission:** contact with infected animals or inhalation of spores (used in bioterrorism)
- **Pathogenesis:** capsule is antiphagocytic and immunogenic; anthrax toxin includes 3 protein components – a protective antigen (B component) that mediates entry of LF or EF into eukaryotic cells; Lethal Factor (LF) kills cells by cleaving map kinase that produces a black eschar (“shield with LF for Viking burning a map creating a black hole”); and Edema Factor (EF) is an adenylate cyclase, which increases cAMP (“shield with EF for Viking in front of tents in a camp”)
- **Disease:**
 - Cutaneous anthrax-papule -> papule with vesicles (malignant pustules) -> central necrosis (eschar) with erythematous border often with painful regional lymphadenopathy (“Vikings burning map standing in a black ring surrounded by flames”)
 - Wool Sorter’s Disease – a life threatening pneumonia with cough, fever, malaise, and ultimately facial edema, dyspnea, diaphoresis, cyanosis, and shock with mediastinal hemorrhagic lymphadenitis and widening (“Sheep’s wool over Viking’s armor and sheep, King Viking is holding lung-shaped axe dripping blood, Viking ship with mast shaped like a chest X-ray with rope widening the mast”)
 - Gastrointestinal anthrax is rare, edema and blockage of GI tract can occur, vomiting, and bloody diarrhea, high mortality
- **Diagnosis:** Gram stain and culture of blood, respiratory secretions or lesions, serology, and PCR
- **Treatment:** Fluoroguinolines like ciprofloxacin (“Viking ship with a flower shield”) or Doxycycline (“shield with wheel spokes”)
- **Prevention:** toxoid vaccine, given to individuals in high risk occupations, like military

Bacillus cereus

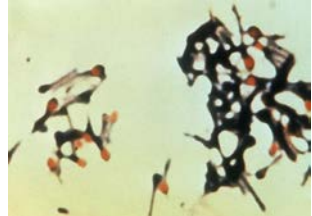
- **Reservoir:** found in nature
- **Transmission:** Foodborne, intoxication; major association with fried rice from Chinese restaurants or foods generally kept warm, not hot (“Viking vomiting while heating a bowl of rice over the flames”)
- **Pathogenesis:** Emetic Toxin comes preformed and attacks fast (1-6 hours), causes vomiting and diarrhea; Diarrheal Toxin produced in vivo is similar to *E. coli*’s LT toxin in that it increases cAMP and causes watery diarrhea
- **Diseases:** gastroenteritis: nonbloody and vomiting can occur
- **Diagnosis:** clinical grounds, culture and gram stain of implicated foods
- **Treatment:** self-limiting





CLOSTRIDIUM TETANI “Rhesus Research Revolution”

- **Distinguishing features:** large, tennis-racquet shaped, gram+ (“violet hues in scene”), **spore-forming** (“walnuts for monkeys to eat”), **rods**; **obligate anaerobes** (“scientists wearing gas masks”), **produces tetanus toxin**
- **Reservoir:** soil; **Transmission:** puncture wounds/ trauma from human bites or nails (“pots of soil everywhere, barbed wire, and rusty nails”), **requires low tissue oxygenation**
- **Pathogenesis:** Spores germinate in the tissues, producing tetanus toxin (an exotoxin also called tetanospasmin); the toxin is carried intra-axonally and retrograde to the CNS (“monkey pulling on a pulley carrying scissors representing toxin retrograde”); there the toxin binds to ganglioside receptors; toxin is a protease that cleaves SNARE protein, which blocks the release of inhibitory mediators (GABA and glycine) from Renshaw cells at spinal synapses (“monkey with toxin scissors cutting snare trap, one is ensnaring a scientist with G and G letters on uniform preventing his release; another scientist emerges from a snare trap next to a monkey holding a wrench and a saw (Renshaw...)”); the excitatory neurons are unopposed, causing extreme muscle spasm
- **Disease:** Tetanus, characterized by risus sardonicus or evil grin from lock jaw (“Rhesus monkey grinning”), opisthotonus, an extension and arching of the back from spasms (“monkey in arched back position”), and general extreme muscle spasms even with the slightest stimulant.
- **Diagnosis:** primarily a clinical diagnosis, organism is rarely isolated
- **Treatment:** hyperimmune human globulin (TIG) to neutralize toxin plus metronidazole or penicillin; spasmolytic drugs (diazepam); debride; delay closure of wound to expose to O₂; the antitoxin only works for free toxin so all the bound toxin will remain in the system
- **Prevention:** Toxoid vaccine is available (“orange syringe”); toxoid is a formaldehyde-inactivated toxin; important because disinfectants have poor sporicidal action; care of wounds – proper wound cleansing and care plus treatment





CLOSTRIDIUM BOTULINUM “Robotulism”

- **Distinguishing features:** Gram+ (“Violet hues”), **spore-forming** (mechanical nuts on the table”), **rods**; **anaerobic** (“scientist wearing oxygen mask”)
- **Reservoir:** Soil/ dust
- **Transmission:** foodborne/ traumatic implantation
- **Pathogenesis:** spores survive in the soil and dust; germinate in moist, warm, nutritious but nonacidic and anaerobic conditions; the botulinum toxin is a A-B polypeptide neurotoxin, coded for by a prophage, is heat labile – 10 minutes at 60°C can inactivate the toxin; it’s MOA is to be absorbed by the gut and then carried by blood the PNS, where it is a protease and cleaves the SNARE protein, blocking the release of Acetylcholine at the myoneuronal junction, resulting in a reversible flaccid paralysis (“scientist holding toxin scissors snipping wires attached to a power supply unit with Ach written).
- **Forms of Botulism is different between Adult and Infant:**

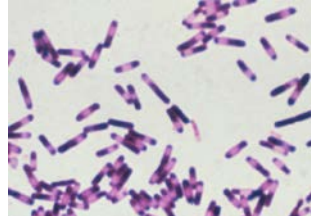


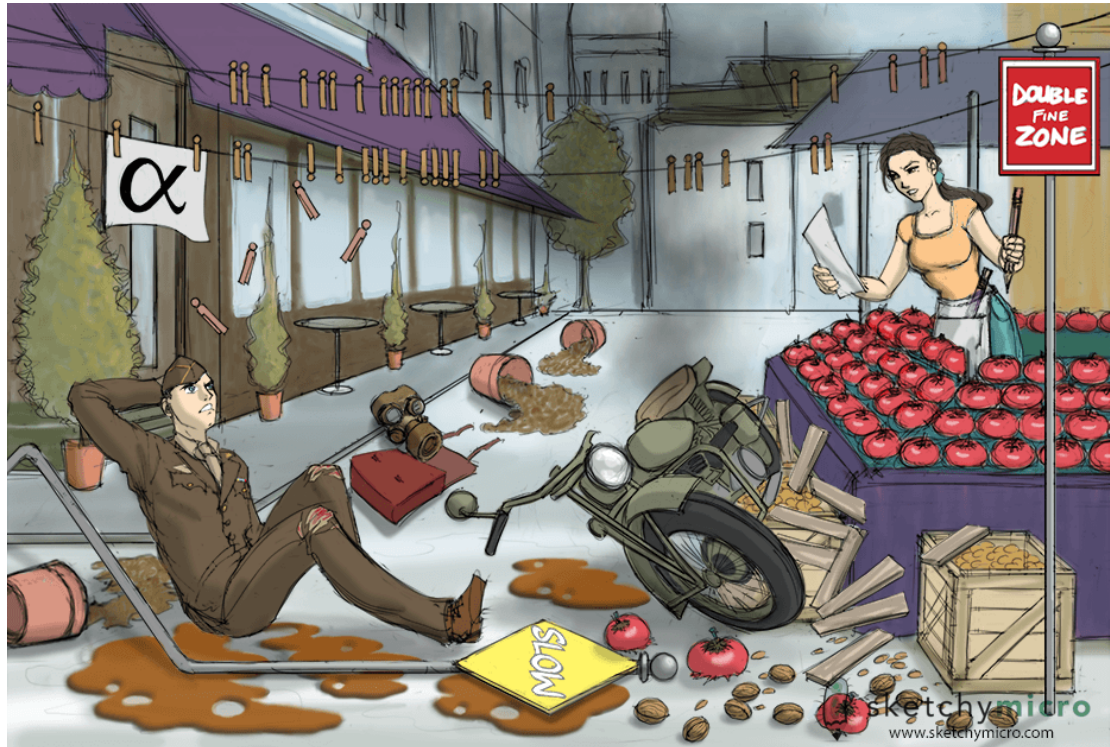
Disease	In Adult	In Infant
Acquisition	PREFORMED TOXIN ingested from poorly canned foods (“robots shaped as cans”), alkaline vegetables (green beans), and smoked fish	SPORES INGESTED from house-hold dust, or Honey! (“honey being poured over baby robot and onto table with spore-nuts”); toxin is then produced in the gut
Symptoms	1-2 day onset of weakness, dizziness, blurred vision, reversible descending flaccid paralysis (“adult robots can’t stand straight with droopy eyelids and lightbulbs turning on in affected regions”), diarrhea, and N/V	Floppy Baby Syndrome (“floppy baby robot”): constipation, limpness/ flaccid paralysis, diplopia, dysphagia, weak feeding/ crying, may lead to respiratory arrest
Toxin Found:	Suspected food or serum	Stool or serum
Treatment	Respiratory support; Trivalent (A-B-E) antitoxin	Respiratory support in ICU; hyperimmune human serum; antibiotics may worsen or prolong by lysing bacterial cell and releasing more toxin
Prevention	Proper canning; heat all canned foods well	No honey given during first year



GENUS: CLOSTRIDIUM – SPECIES: DIFFICILE “Field Trip to the Chocolate Factory”

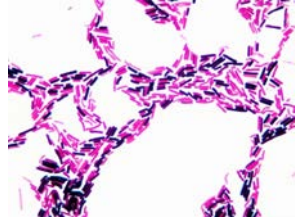
- **General features:** Gram+ rods (“violet hats”), **spore forming** (“walnuts on conveyer belt”), **Obligate Anaerobe** (“gas masks”)
- **Reservoir:** human colon/ gastrointestinal tract
- **Transmission:** endogenous
- **Pathogenesis:** two toxins produced
 - **Toxin A (“A for Apples”):** enterotoxin damaging brush border mucosa leading to **fluid increase** (“worker brushing on the chocolate diarrhea to represent brush border”); **granulocyte attractant**
 - **Toxin B (“B for Black Licorice”):** **cytotoxin; cytopathic** – the toxin disrupts the cytoskeleton integrity by **depolymerizing actin** (“child eating the licorice which look like actin”); **this causes enterocyte death and necrosis and a buildup of yellow-gray exudate forming a pseudomembrane covering the colonic mucosa, a pseudomembrane colitis** (“represented by packaging the licorice in sheets of yellow plastic”)
- **Diseases:** antibiotic associated diarrhea, colitis, or pseudomembranous colitis – antibiotic is typically Clindamycin (“Clean sign for clean-damycin over the chocolate diarrhea”); **other antibiotics include cephalosporins, amoxicillin, ampicillin**; a nosocomial diarrhea
- **Diagnosis:** culture is not diagnostic because the organism is part of normal flora; instead a stool exam for the toxin production is conducted by PCR = represented by kid playing in chocolate diarrhea losing a shoe that represents the toxin that is later picked up by a worker
- **Treatment:** in mild disease, **discontinue the antibiotic therapy**; in severe cases, **treat with metronidazole** (“metro train”) or use **oral vancomycin** (“vanco van with tongue shaped loading ramp”) **only if no other drug is available**
- **Prevention:** caution in overprescribing broad-spectrum antibiotics (limited-spectrum drugs should be considered first); in the nursing home setting, patients who are symptomatic should be isolated; autoclave bed pans for treatment that kills spores; hand wash diligently (“clean hand washing sign”)





CLOSTRIDIUM PERFRINGENS “Private Ringen’s Motorcycle Crash”

- **Distinguishing Features:** large, gram+, spore-forming (“walnuts on the ground”), rods, nonmotile, anaerobic (“gas mask”), stormy fermentation in milk media; creates double zone of hemolysis on blood agar (“double fine zone sign”); identified by Nagler Reaction – egg yolk agar plate, one side with antitoxin-alpha-toxin; lecithinase activity is detected on side with no antitoxin
- **Reservoir:** soil and human colon (“pots of soil knocked over”)
- **Transmission:** foodborne and traumatic implantation; infection is associated with open wounds and dirt getting in, often associated with the military and motorcycle accidents (“scene is of a military guy falling off his motorcycle”)
- **Pathogenesis:**
 - Spores germinate under anaerobic conditions in tissue; the vegetative cells produce an alpha toxin (phospholipase C), which is a lecithinase (“flag with Alpha symbol hanging from clothes line”); it disrupts the phospholipid bilayer membrane (“clothes pin arranged to represent phospholipid bilayer”); this damages RBCs, platelets, WBCs, and endothelial cells leading to massive hemolysis, tissue destruction and hepatic toxicity (“smashed tomatoes on the ground from accident”)
 - Enterotoxin produced in intestines in food poisoning: disrupts ion transport leading to watery diarrhea, cramps
- **Disease(s):**
 - Gas gangrene (myonecrosis): from contamination of wound with soil or feces, causes acute and increasing pain at wound site and tense tissue (edema, gas) and exudate; systemic symptoms include fever and tachycardia, diaphoresis, pallor; rapid, high mortality if untreated (“represented by gas coming from motorcycle”)
 - Food poisoning: reheated meat dishes, organism grows to high numbers; slow onset of 8-24 hour incubation (“motorcyclist knocking over ‘Slow’ sign”), enterotoxin production in gut produces self-limiting noninflammatory, watery diarrhea (“motorcyclist sitting in muddy water”)
- **Diagnosis:** clinical; **Treatment:** for the Gangrene – debridement, delayed closure for prolonged exposure to O₂, clindamycin, and IV penicillin G (“shopkeeper holding a pencil”), hyperbaric chamber; for food poisoning – self-limiting, resolves in 24 hours
- **Prevention:** extensive debridement of the wound plus administration of penicillin



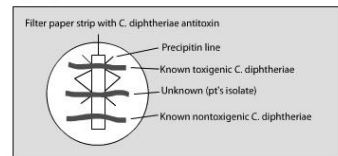


CORYNEBACTERIUM DIPHTHERIAE “Corazon de la Corrida”

- **General features:** Gram+ (“violet hues”), Aerobic, gray-to-black colonies of club-shaped rods arranged in V or Y shapes on gram stain (“maracas designed to look club-shaped with blue and red colors and V-patterns”), Granules (volutin) produced on Loeffler (“kid laughing at arena”) coagulated serum medium stain metachromatically. Also grows on Tellurite media (“Tele screen”) Toxin-producing strains have beta-prophage carrying genes for the toxin. The phage from one patient with diphtheria can infect the normal nontoxigenic diphtheroid of another person and cause diphtheria.
- **Reservoir:** throat and nasopharynx
- **Transmission:** bacterium or phage via respiratory droplets (“saliva from bull’s mouth”)
- **Pathogenesis:** organism is not invasive; colonizes epithelium of oropharynx or skin in cutaneous diphtheria; diphtheria toxin (A and B components) inhibit protein synthesis by adding ADP-ribose to eEF-2, interfering with elongation (“man wearing a bow-tie that indicates ribosylation playing an accordion that elongates”). Effect on oropharynx is a dirty gray pseudomembrane (“kids holding cotton candy wrapped in gray packaging”) that is made up of dead cells and fibrin exudate, bacterial pigment; it bleeds when scraped off. The effects can extend into the larynx/ trachea and cause lymphadenopathy, giving a bull’s neck appearance (“Bull exposing his large neck”). This can cause obstruction. Systemic effects once the toxin reaches systemic circulation include cardiac and nerve damage.
- **Disease:** Diphtheria presents with a sore throat with pseudomembrane, bull neck, potential respiratory obstruction, cardiac effects of myocarditis, arrhythmia, and heart block (“matador’s heart-shaped cape”), and nerve damage such as recurrent laryngeal nerve palsy and lower limb polyneuritis (“man in crowd eating sausage links to represent myelinated nerves”)
- **Diagnosis:** Elek test (“Bull’s tongue out to lick”) to document toxin production – ELISA for toxin is now the frontline; toxin produced by toxin-producing strains diffuses away from growth. Antitoxin diffuses away from the strip of filter paper. Precipitin lines form at zone of equivalence.
- **Treatment:** Erythromycin and antitoxin to neutralize the toxin; for endocarditis, IV penicillin and aminoglycosides for 4-6 weeks.
- **Prevention:** toxoid vaccine (“syringes into side of bull”), a formaldehyde-modified toxin is still immunogenic but with reduced toxicity; part of DTaP, DTP, or Td; boosters at 10-year intervals; check for vaccination history.



ELEK test:





LISTERIA MONOCYTOGENES “Santa’s List”

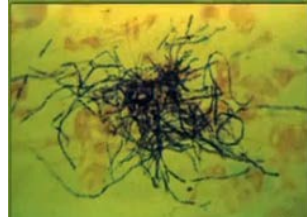
- **General features:** small, gram+ rods (“purple ornaments on tree that are in rod shape”), **facultative intracellular parasite, beta hemolytic** (“beta light bulb on top of tree”), **catalase+** (“cat”), **CAMP positive, Tumbling motility** (“ornaments tumbling down the tree”) – they have **actin jet motility that allows them to travel cell to cell** (“jet rocket presents”), **grows in the cold** (“it’s an icy, cold, winter night”)
- **Reservoir:** widespread – animals’ GI and genital tracts, **unpasteurized milk products, plants, and soil**; for cold growth – soft cheeses (“milk and cheese set out for Santa”), deli meats, cabbages (coleslaw), hotdogs, ice cream
- **Transmission:** foodborne, vertical or across the placenta (“pregnant woman in the scene”)
- **Pathogenesis:** Listeriolysin O, a beta-hemolysin: facilitates rapid egress from phagosome into cytoplasm, thus evading killing when lysosomal contents are dumped into phagosome; “jets” directly by actin filament formation from cytoplasm to another cell; immunologic immaturity predisposes to serious infection
- **Diseases:**
 - Listeriosis (human, peaks in summer); affects healthy adults and children; generally asymptomatic or diarrhea with low % carriage. In pregnant women – symptomatic carriage, septicemia characterized by fever and chills; can cross the placenta in septicemia.
 - Neonatal disease: Early onset – granulomatosis infantisepticum in utero transmission; sepsis with high mortality; disseminated granulomas with central necrosis. Late onset – 2-3 weeks after birth from fecal exposure; meningitis with septicemia (“baby with meningitis helmet”)
 - In immunocompromised patients (“Santa representing the elderly”): **Septicemia and meningitis**; Listeria meningitis is most common cause of meningitis in renal transplant patients and adults with cancer.
- **Diagnosis:** Blood or CSF culture; CSF wet mount on Gram stain
- **Treatment:** Ampicillin (“guitar with amp by the tree”) with gentamicin added for immunocompromised patients
- **Prevention:** pregnant women or immunocompromised patients should not eat cold deli foods.





ACTINOMYCES ISRAELI “Israeli Soldier”

- **General features:** gram+ (“purple wrap”), branching, filamentous rods (“tree in scene with many branches”), anaerobic (“gas mask”)
- **Reservoir:** human; normal flora of gingival crevices and female genital tract
- **Transmission:** endogenous
- **Pathogenesis:** invasive growth in tissues with compromised oxygen supply
- **Disease:** actinomycosis – generally not painful but very invasive, penetrating all tissues, including bone. Tissue swelling leads to the formation of sinus tracts and draining abscesses (“canal with storm drain next to soldier”) with yellow sulfur granules (“yellow rocks around soldier”) in exudate that can be used for microscopy or culture; very foul smelling. Tissue swelling occurs typically in tissues with low oxygenation:
 - Cervicofacial lumpy jaw (“jaw wrap around soldier’s head”): from dental trauma or poor oral hygiene
 - Pelvic: from thoracic or sometimes IUDs
 - Abdominal: surgery or bowel trauma
 - Thoracic: aspiration with contiguous spread
 - CNS: solitary brain abscess
- **Diagnosis:** Identify gram+ branching bacilli in sulfur granules; colonies resemble a molar tooth
- **Treatment:** ampicillin or penicillin G (“soldier holding a pencil”) and surgical drainage in severe cases.

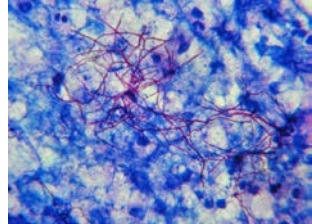




GENUS: NOCARDIA “No Card Game for Old Men”

SPECIES: ASTEROIDES AND BRASILIENSIS

- **General features:** Gram+, filamentous-branching rod (“branching tree from Actinomyces’ image in painting”), aerobic (“air bellow under painting”), **partially acid fast** – some areas of smear will be blue and some red; this is because the carbol fuchsin stain used for acid fast staining is taken up if the cell wall has mycolic acid, a long chained fatty acid with two tails (“main cowboy drawing gun fast to show acid fast; he’s wearing a shawl and chaps that have tassels with two long chains”), **catalase+** (“bartender holding a cat”), and **urease+** (“ammonia spray bottle on counter”)
- **Reservoir:** soil and dust (“cactus pots leaking soil”)
- **Transmission:** airborne or traumatic transplantation
- **Pathogenesis:** no toxins or virulence factors known; immunosuppression and cancer (“second cowboy holding the immunocompromised cane”) **predisposes to pulmonary infection**
- **Diseases:**
 - **Nocardiosis** – cavitary bronchopulmonary nocardiosis; can be acute, subacute, chronic and presents with symptoms of cough, fever, dyspnea, localized or diffuse pneumonia with cavitation (“second cowboy coughing with a bullet hitting his badge on his chest”); **may spread hematogenously to the brain creating brain abscesses of multiple foci** (“second bullet penetrating cowboy’s hat”)
 - **Cutaneous/ subcutaneous nocardiosis** – starts with traumatic implantation and presents with symptoms of cellulitis and swelling (“second cowboy is wearing cow print that has spots with red borders”); **leads to draining subcutaneous abscesses with granules, mycetoma**
- **Diagnosis:** culture of sputum or pus from cutaneous lesion
- **Treatment:** high dose sulfonamides (“rotten eggs on counter for foul sulfur smell”) or trimethoprim/ sulfamethoxazole (TMP-SMX)



NOIR SERIES



Vice City

PRIVATE
INVESTIGATOR

Starring
THAYER "MAC"
MARTIN as PRIVATE EYE

5 - 9 PM



sketchymicro

www.sketchymicro.com

GENUS: NEISSERIA “Noir Series”

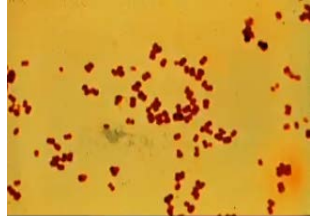
➤ *Genus Features:*

- **Gram- diplococci with flattened sides** (“red handcuffs”)
- **Oxidase+** (“blue ring on detective’s hand”)
- **Grows on chocolate agar in 5% CO₂ atmosphere** (“detective holding a chocolate bar”)
- **Grows on VPN agar** (“Vice city Private Nvestigator sign”); **also called Thayer-Martin medium** (“poster reads ‘Starring Thayer Martin’”)
- **Deficiency in late complement components C5-9, unable to form MAC complex, predisposes individuals to bacteremia** (“detective’s name is MAC; show time is from 5-9pm”)
- **Has IgA protease that cleaves IgA at hinge region and allows for oropharynx colonization** (“Ace card with IgA dimer symbol on detective’s hat”)
- **Pili allows for attachment onto mucosal surfaces, inhibits phagocytic uptake, and has 1 million antigenic variations** (“detective has pocket watch with many different chains to indicate variable pili”)

➤ *Species of Medical Importance: N. MENINGITIDIS AND N. GONORRHOEAE*

➤ *Differences between the two species:*

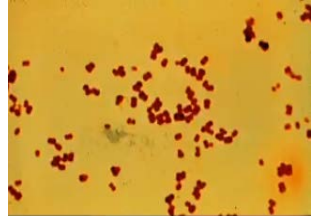
<i>Organism</i>	<i>Capsule</i>	<i>Vaccine</i>	<i>Portal of Entry</i>	<i>Glucose Fermentation</i>	<i>Maltose Fermentation</i>	<i>B-lactamase Production</i>
<i>N. meningitidis</i>	+	+	Respiratory	+	+	Rare
<i>N. gonorrhoeae</i>	-	-	Genital	+	-	Common





NEISSERIA MENINGITIDIS “A Shocking Death on Campus”

- **General Features:** Gram-, kidney bean-shaped diplococci, oxidase+, grows on chocolate agar. Ferments maltose (“Investigator is investigating the MALT liquor”), has large polysaccharide capsule (“glass cases on floor”); latex particle agglutination to identify capsular antigens in CSF
- **Reservoir:** human nasopharynx (5-10% carriers)
- **Transmission:** respiratory droplets; oropharyngeal colonization (“investigator analyzing bottle with nasopharynx swab”); spreads to the meninges via the bloodstream; disease occurs in only small percentage of colonized individuals; infections common in dormitory settings or small, closed areas (“scene is college dorm room”)
- **Pathogenesis and important virulence factors:**
 - IgA protease allows oropharynx colonization, pili and outer membrane proteins important to ability to colonize and invade; deficiency in late complement components C5-9 predisposes to bacteremia (details in overview)
 - Polysaccharide capsule is antiphagocytic and antigenic; there are 5 common serogroups – A, B, C, W-135, and Y – B is not strongly immunogenic (Sialic acid); B strain is most common strain in US; capsule is used for serogrouping, detection in CSF, and vaccines (“glass case around syringes representing vaccines for A, C, and D, but no syringe in case B”)
 - Endotoxin (lipooligosaccharide): the over production of the outer membrane envelope causes an inflammatory response (“envelopes on the floor on fire”), leading to leaky capillaries (“water sprinkles leaking”), ultimately leading to fever, septic shock (“water on the electrical outlet”) in meningococemia
 - Patients with sickle cell disease or asplenia have greater risk of infection (“sickle and hammer flag on wall”)
- **Diseases:** Meningitis and meningococemia – abrupt onset with fever, chills, malaise, prostration, and a rash that is generally petechial (“wet spots on carpet and red spots on boxers indicate petechial rash”); petechial rash indicates thrombocytopenia and is generally not a good sign – leads to rapid decline. Fulminant cases have ecchymoses, DIC, shock, coma, and death – and hemorrhage of adrenals – characteristic of Waterhouse-Friderichsen Syndrome (“Waterhouse outside window”)
- **Diagnosis:** Gram stain of the CSF, PCR, Latex agglutination
- **Treatment:** for neonates/ infants – ampicillin and cefotaxime. For older infants, children and adults – cefotaxime or ceftriaxone (“firefighter on scene with 3 axes”)
- **Prevention:** Vaccine is capsular polysaccharide of strains Y, W-135, C, and A – Type B (50% of cases in US) capsule is not a good immunogen; prophylaxis for close contacts is given – Rifampin (“friends of victim barred from entering room by police carrying a RiFle”) or ciprofloxacin; now given to all children.





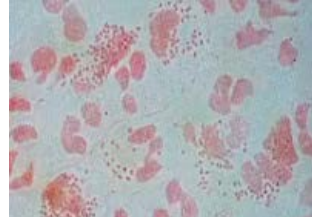
Donzos

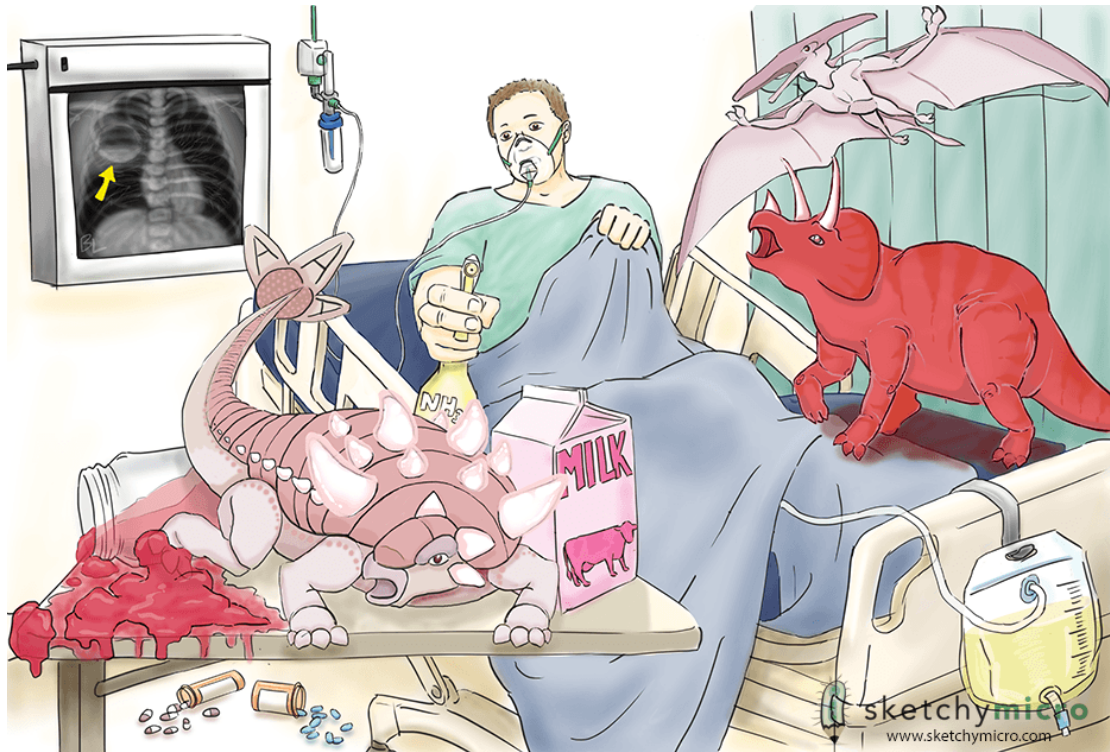
featuring

Fitz Hush Curtis Band

NEISSERIA GONORRHOEAE “The Violinist’s Last Clap”

- **General Features:** Gram-, kidney bean-shaped diplococci, oxidase+, grows on chocolate agar, does not have a capsule (“glass capsule case broken on the floor”)
- **Reservoir:** human genital tract
- **Transmission:** sexual contact (“detective flirting with woman at the bar”), birth (“mother holding baby”), sensitive to drying and cold
- **Pathogenesis:** pili allows for attachment to mucosal surfaces, inhibits phagocytic uptake, has antigenic variation; has outer membrane proteins – OMP I, a structural antigen used in serotyping; Opa proteins that has antigenic variation, allows for adherence; and IgA protease; organism invades mucosal surfaces and causes inflammation
- **Disease:** gonorrhea
 - **Male:** urethritis, proctitis or orchitis
 - **Female:** endocervitis and pelvic inflammatory disease, PID (“chandelier shaped as ovaries and uterus with candles indicating inflammation”), this produces purulent discharge (“candles dripping hot wax onto table”), and can spread to the peritoneum causing Fitz-Hugh-Curtis Syndrome, which can cause long, thin “violin-string” adhesions to the capsule of the liver (“Fitz-Hugh-Curtis string orchestral band with violinist’s violin in foreground”). This can also present with asymmetrical arthritis (“statue crushing violinist has a crack in one knee”) and proctitis
 - **Infants:** ophthalmia and conjunctivitis that rapidly leads to blindness if untreated (“mother holding baby covering baby’s eyes”)
- **Diagnosis:** Intracellular gram- diplococci in PMNs (“white chairs in foreground shaped as neutrophils with high backs and reflections to represent nucleus with two red pillows to represent diplococci”) from urethral smear from symptomatic male are suggestive of infection
 - **Commonly:** diagnosis by genetic probes with amplification; culture when done on Thayer-Martin medium
- **Treatment:** ceftriaxone (“statue with 3 axes and 3 axe emblem on signs above orchestral band”), must also test for *C. trachomatis* and assume coinfection (“clam shaped napkins on the table”) or treat with doxycycline; penicillin-binding protein mutations led to gradual increases in penicillin resistance from the 1950s-70s; plasmid-mediated beta-lactamase produces high level penicillin resistance

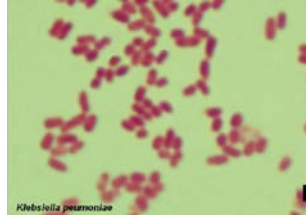




Enterobacter cloacae, Serratia marcescens, and KLEBSIELLA PNEUMONIAE

“Enterodactyl, Triserratiatops, and the Kleb-Tailed Dinosaur”

- **General Features:** all gram- rods, lactose fermenting producing pink colonies on MacConkey agar (“pink milk carton”), they are multi-drug resistant (“antibiotic pills spilled on the floor”), and all three cause pneumonia (“patient has oxygen mask”) and UTIs (“bag of urine at the end of his bed”)
 - **Enterobacter is motile** (“enterodactyl is flying over patient”)
 - **Serratia is motile** (“triserratiatops is charging forward”), and produces red pigment when cultured – typically producing the pink ring found in showers (“triserratiatops is bright red”)
 - **Klebsiella is more high yield: nonmotile** (“kleb-tailed dinosaur is stuck in the jelly”), **urease+** (“patient spraying dinosaur with ammonia bottle”), has large polysaccharide capsule (“spikes are covered in mucus”), associated with 3 A’s – Alcoholics, Abscesses, Aspiration (“kleb-tailed dinosaur’s 3 A-shaped clubbed tail”)
- **Reservoir:** human colon and upper respiratory tract
- **Transmission:** endogenous
- **Pathogenesis:** the capsule of *Klebsiella* impedes phagocytosis; endotoxin causes fever, inflammation and shock
- **Diseases, more specific to Klebsiella:**
 - **Pneumonia:** community-acquired (“hospital setting”), most often in older males; most commonly in patients with either chronic lung disease, Alcoholism, or diabetes; assumed to reach the lungs by inhalation of respiratory droplets – Aspiration – from upper respiratory tract; frequent Abscesses make it hard to treat and fatality rate is high; the sputum is generally thick and bloody like currant jelly (“Kleb-Tailed dinosaur knocking over jar of currant jelly”), but not foul smelling
 - **Urinary Tract Infections** are catheter-related (nosocomial) from fecal contamination of catheters
 - **Septicemia** in immunocompromised patients may originate from bowel defects or invasion of IV lines
- **Diagnosis:** culture of sputum or clean catch urine sample; lactose fermenter on MacConkey agar
- **Treatment:** Third-generation cephalosporin with or without an aminoglycoside; fluoroquinolones may also be used
- **Prevention:** good catheter care, limit use





GENUS: SALMONELLA “Salmon Dinner”

- **General features:** gram- rods, enterobacteriaceae, non-lactose fermenters, motile flagella (“salmon tail flapping”), and produces H_2S , which produces black colonies on Hektoin agar (“black plate”), encapsulated (“glass case over the fish”), acid-labile (“lemons next to the salmon”)

Salmonella typhi (or *S. enterica* subtype *typhi*):

- **Distinguishing features:** Vi capsule, facultative anaerobe
- **Reservoir:** Humans only (no animals)
- **Transmission:** fecal-oral route from human carriers, enters the gall bladder (“seagull wearing an apron to indicate Mary, the chef who caused a typhoid outbreak”); decreased stomach acid or impairment of mononuclear cells such as in sickle cell disease predisposes to *Salmonella* infections
- **Pathogenesis and Disease:** Typhoid or Enteric Fever (milder form of paratyphoid caused by *S. paratyphi*)
 - Large quantity of organism is ingested, infection begins in ileocecal region, *Salmonella* reach basolateral side of M cells, then mesenteric lymph nodes and blood (transient 1st septicemia). At week 1, patients have 80% positive blood cultures; 25% have rose spots on trunk and abdomen (“apron with red spots”); Liver and spleen are infected with additional release of bacteria to bloodstream > signs of septicemia, mainly fever. *S. typhi* survives intracellularly and replicates in macrophages (“bird cages with Mφ that are open”); resistant to macrophage killing is due to decreased fusion of lysosomes with phagosomes and defensins allow it to withstand oxygen-dependent and oxygen-independent killing; released from the macrophage, the Vi capsular antigen withstands complement-mediated killing.
 - Biliary system is infected and organisms enter the intestinal tract in the bile; by week 3, 85% of stool cultures are positive. Symptoms include fever, headache, abdominal pain, and constipation, which can lead to pea-soup diarrhea (“green bird droppings”); complications if left untreated lead to necrosis of Peyer patches with perforation, thrombophlebitis, cholecystitis, pneumonia, abscess formation, etc.
- **Treatment:** fluoroquinolones (“flower in vase”) or 3rd generation cephalosporins
- **Prevention:** sanitation; three vaccines available – an attenuated oral vaccine of Ty21a strain (“syringe”), parenteral heat-killed, and parenteral ViCPS polysaccharide capsular vaccine

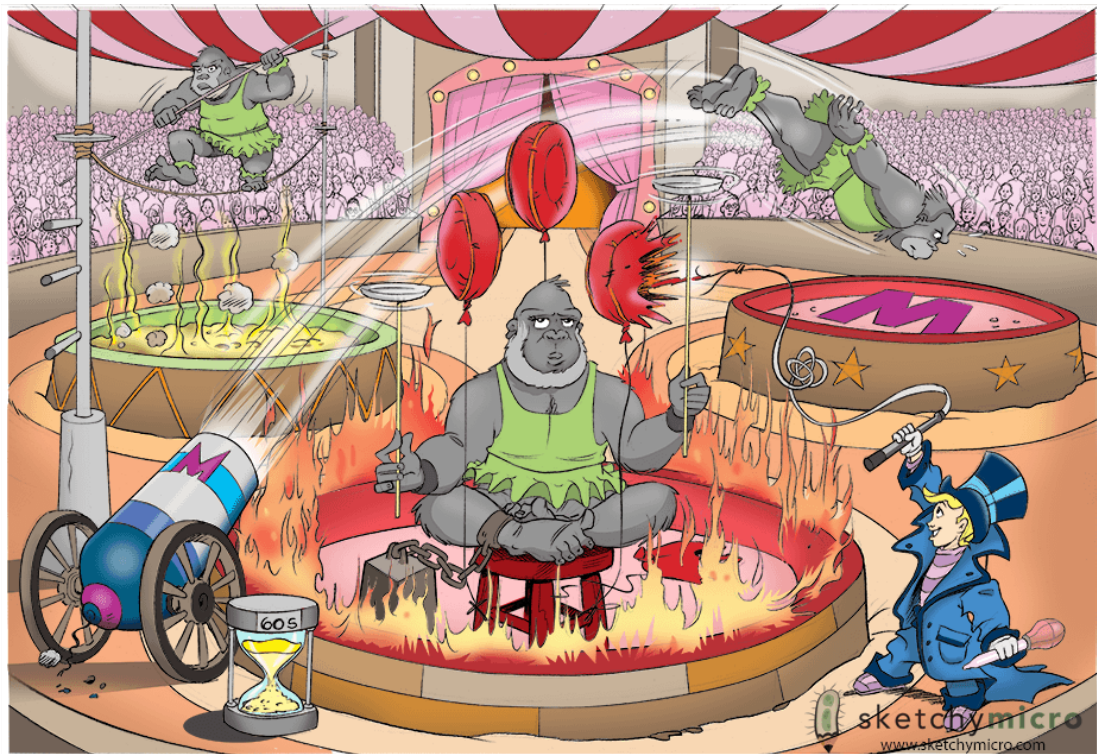
Salmonella enteritidis (or *S. enterica* subtype *enteritidis*)

- **Distinguishing features:** Antibodies to O, Vi, and H antigens in serum can be detected by agglutination (Widal Test)
- **Reservoir:** enteric tracts of humans and animals (chickens and turtles); **transmission** is largely through chicken products or reptile pets; **pathogenesis** is invasive leading to inflammatory diarrhea (“chicken lighting the candle”)
 - Invades the mucosa in the ileocecal region, invasive to lamina propria > inflammation > increase PG > increased cAMP > loose diarrhea
- **Diseases:** Enterocolitis/ gastroenteritis: second most common bacterial cause after Campy; 6-48 hr incubation, nausea, vomiting, only occasionally bloody, loose stools, fever, abdominal pain, myalgia, headache. Virulence factor produces Type III secretion factor that detects eukaryotic cells and secretes protein that helps with infectivity = “turkey baster”
- **Treatment:** it is self-limiting; antibiotics are contraindicated; **Prevention:** properly cook foods and wash hands

Salmonella choleraesuis, *paratyphi*, *enterica*, and *Dublin* can all cause septicemia (but *typhi* still most severe); endocarditis or arthritis complicates about 10% cases.

Salmonella is the most common causal agent of osteomyelitis in sickle cell disease patients (>80%) = “seagull holding sickle over bony head of the fish”.





GENUS: SHIGELLA "She-Gorilla Circus, a gorilla wearing a tutu to indicate She"

- **Genus features:** Gram- rod, enterobacteriaceae, non-lactose fermenter (colorless colonies on eosin-methylene blue agar or MacConkey), Non H₂S producers, non-motile ("she-gorilla is chained to the ring"), and also grows green colonies on hektoin agar ("green tutu").
- **Species of Medical Importance**
 - *Shigella sonnei* (most common in the US)
 - *Shigella dysenteriae* (most severe disease, common in developing countries)
 - *Shigella boydii*, *Shigella flexneri*
- **Reservoir** – human colon only (no animal carriers)
- **Transmission** – fecal-oral spread, persons to person (common in day cares amongst children!)
- **Pathogenesis** – has an endotoxin that triggers inflammation ("She-gorilla is sounded by flames"); the endotoxin uses a Type III secretion system to secrete inflammatory cytokines ("Child holding a turkey-baster")
 - *Shigella* is acid-resistant ("She-gorilla is walking a tight rope over an acid pool"), and only a few organisms are required to start an infection – scale of 10-100's. *Shigellae* invade M cells, found in Peyer's patches, and gets macropinocytosed into the cytoplasm, where they replicate and then polymerize the cell's actin jet trails to go laterally without going back into the extracellular milieu ("She-gorilla propels from an M-canon to represent the use of actin filaments and lands on an M pad to represent invasion of M cells"). This allows shigella to avoid the immune system and produces very shallow ulcers to cause bloody diarrhea ("red stools").
 - Shiga toxin (like EHEC's toxin) is produced by *S. dysenteriae*, type 1. It is neurotoxic, cytotoxic, and enterotoxic. The AB component toxin is internalized in human cells; it inhibits protein synthesis by clipping the 60s ribosomal subunit ("60s hour glass to perform the trick"); this toxin in children under 5 increases the risk for HUS, which causes glomerular damage ("child ring master holding a tangled-string") that activates platelet aggregation, decreasing platelet count ("She-gorilla spinning plates"), which ultimately lyses RBCs causing hemolysis ("string popping red balloons").
- **Disease** – Enterocolitis/ shigellosis (most severe form is dysentery); has a 1-4 day incubation, organisms invade, producing a bloody, inflammatory diarrhea so presents with fever, lower abdominal cramps, tenesmus, diarrhea that is at first watery, then bloody. Severity depends on the age of the patient and the strain.
- **Treatment** – it is mostly self-limiting, so fluid and electrolyte replacement; severe cases require antibiotics
- **Prevention** – proper sanitation (sewage, clean drinking water, hand washing)





GENUS: ESCHERICHIA “E. coli’s Soda Fountain”

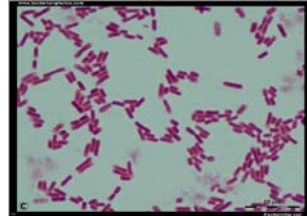
Genus features:

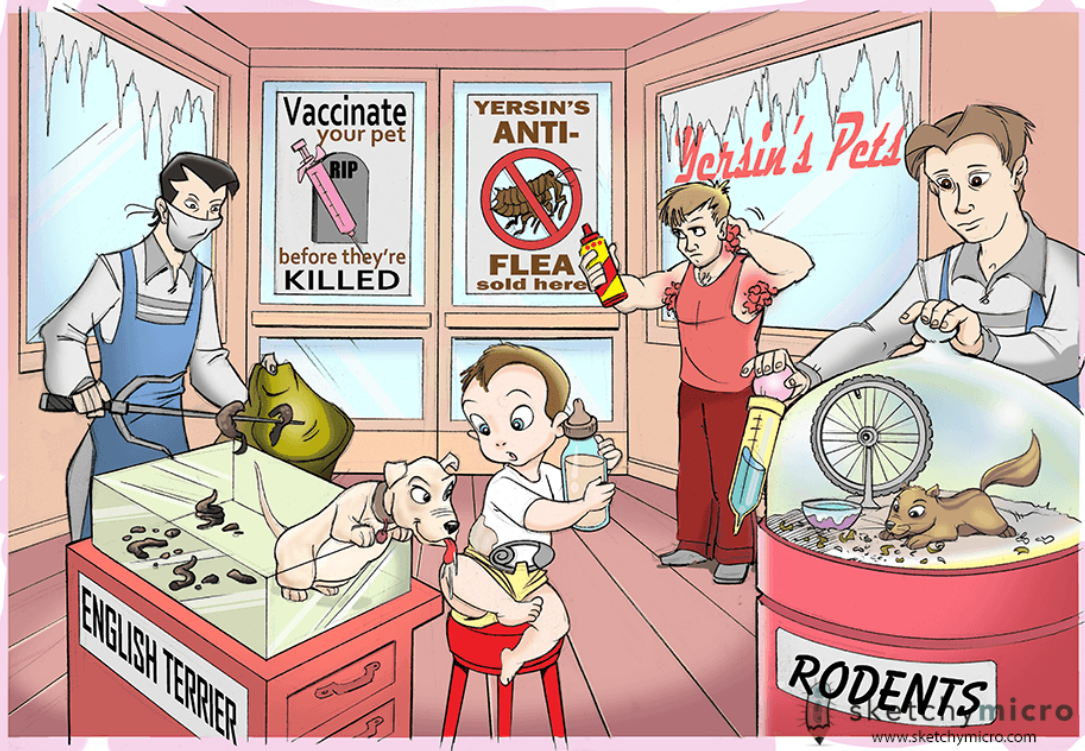
- Gram- rods, enterobacteriaceae
- Ferments lactose, which grows pink on MacConkey Agar = “pink milk carton”; and the colonies grow with an iridescent green sheen on Eosin-Methylene Blue Agar = “green coasters”
- Catalase positive = “cat!”
- Facultative anaerobic, oxidase negative

Reservoir - Human colon; may colonize vagina or urethra; **Treatment** is supportive, rehydration in severe cases

Diseases:

- #1 cause of UTI's – endogenous fecal flora contaminate and ascend the urethra, more common in females because of shorter urethras, and mechanism is due to fimbriae or pili that allows for adherence to uroepithelium = “girl with fimbriae bow drinking #1 glass with yellow liquid”
- #2 most common cause of neonatal meningitis when maternal fecal flora contaminate during parturition; mechanism is through bacteria's capsule that has a K1 serotype antigen = “little child with meningitis helmet reaching out to an encapsulated K-cake”
- Septicemia (gram-), caused by LPS endotoxin = “pink milkshakes”
- Gastroenteritis – ETEC, EHEC, also EPEC (pathogenic/pediatric), EIEC (invasive/inflammatory)
 - EHEC: enterohemorrhagic strain
 - come from bovine fecal contamination served in undercooked meat or at petting zoos, etc = “hamburger”
 - Causes bloody diarrhea that is not inflammatory – no fevers or pus = “bloody ketchup spill and red stool”
 - EHEC can be tested on a SMac plate because it does not ferment sorbitol = “sorbitol-free bottle”
 - The toxin inhibits protein synthesis by interfering with 60s ribosomal subunit – Shiga-Like toxin = “shigorilla happy meal toy in kid's lap”
 - O157:H7 serotype = “Sign for burgers selling for \$1.57”
 - In children, EHEC infection may progress to HUS, which occurs when the bacteria damages the endothelial cells in the glomerulus (“child drinking out of straw with glomerulus”), becoming thrombogenic, which causes platelets to aggregate and decrease in platelet count (“used up dirty sticky plates”); the clumps of platelets lyse RBCs, causing hemolysis (“red balloon popped by the straw”)
 - ETEC: toxigenic strain/ cause of traveler's diarrhea, often to and from Mexico = “traveling truck with Mexican writing”
 - Transmitted via fecal-oral route through contaminated water = “water delivery truck”
 - Causes explosive watery diarrhea = “delivery truck driver holding water jugs standing on brown stools”
 - Mechanism from two toxins – LT, heat-labile toxin, which stimulates Adenylate cyclase; and ST, stable toxin, which stimulates Guanylate cyclase – both results in increase in chloride and water into the small intestines = “eL Agua de San Gabriel sign on the truck for LT – cAMP and ST – cGMP”
 - Capsule impedes phagocytosis; colonizing factor adhesins bind to the mucosa
 - Diagnosis by immunoassay, DNA probes, Serotyping, and PCR





GENUS: YERSINA “Yersin and his Pets”

SPECIES: PESTIS AND ENTEROCOLITICA

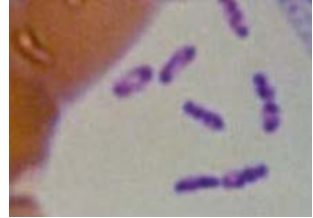
- **General Features:** gram- rods (“red hues”); **enterobacteriaceae**

Yersinia enterocolitica (“the English Terrier”)

- **Distinguishing Feature:** motile at 25°C, nonmotile at 37°C; grows in the cold (“icicles outside seen in windows”)
- **Reservoir:** zoonotic, often transmitted through puppy feces (“English Terrier pooped a lot”); kids are most affected (“toddler next to the puppy”)
- **Transmission:** unpasteurized milk, pork (“toddler is holding a bottle of milk”); is prominent in northern climates (Michigan, Scandinavia)
- **Pathogenesis:** Enterotoxin, endotoxin, multiplies in the cold
- **Disease:** Enterocolitis – presentations may vary with age. In the very young: febrile diarrhea with blood and pus (“toddler sitting on a red stool”). In older kids/ young adults: pseudoappendicitis (“puppy licking RLQ of toddler”). In adults: enterocolitis with postinfective sequelae like reactive arthritis. Blood transfusions-associated infections can also be caused by *Y. enterocolitica*.
- **Diagnosis:** stool culture at 25°C, cold enrichment; bipolar staining like a safety-pin (“safety pin on toddler’s diaper”)
- **Treatment:** supportive care; for immunocompromised – fluoroquinolones or third-generation cephalosporins

Yersinia pestis (“Rodents”)

- **Distinguishing Feature:** bipolar staining, facultative intracellular parasite, coagulase positive, nonmotile and H₂S-
- **Reservoir:** zoonotic, US desert southwest – rodents, esp prairie dogs (“prairie dog in the rodent cage”), chipmunks, and squirrels; a potential biowarfare agent
- **Transmission:** wild rodents flea bite (“Yersin’s Anti-Flea spray sold here’ sign on door”) causes sylvatic plague; human to human transmission by respiratory droplets is very contagious
- **Pathogenesis:** coagulase-contaminated mouth part of flea; endotoxin and exotoxin; envelope antigen (F-1) inhibits phagocytosis; Type 3 secretion system (“Turkey baster symbol used to fill up water”) suppresses cytokine production and resists phagocytic killing
- **Diseases:** Bubonic plague aka black death from flea bites of infected animals and later uninfected humans – presents with symptoms of rapidly increasing fever, conjunctivitis, and regional buboes or very swollen lymph nodes (“guy buying spray with buboes”); can lead to septicemia and death if untreated – affected areas turned black. Also Pneumonic Plague can be used as biological warfare – it arises from septic pulmonary emboli in bubonic plague or inhalation of organisms from infected individual – this is highly contagious and extremely fatal.
- **Diagnosis:** clinical specimens and culture are hazardous; serodiagnosis or indirect immunofluorescence is safest; safety pin staining
- **Treatment:** aminoglycosides (“worker with scythe to pick up puppy feces”) and tetracyclines (“bike wheel and running wheel for rodent”)
- **Prevention:** animal control – avoid sick and dead animals; killed vaccine (“poster on wall that reads ‘Vaccinate your pet before they’re KILLED’”) for those at high risk, i.e. military





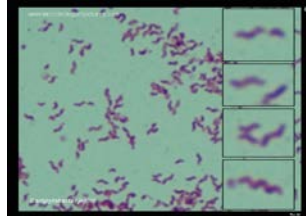
GENUS: CAMPYLOBACTER JEJUNI “Camping Guy and the Bears”

Genus features:

- Gram-, curved rods with polar flagella (“gulls wings”) = “curved-shaped mustache”

- Oxidase positive = “blue ring”

- **Distinguishing Features** – microaerophilic (likes less O₂ and more CO₂), and grows well at 42°C (thermophilic) on Campy medium or Skirrow agar = “campfire”
- **Reservoir** – intestinal tracts of humans, cattle, sheep, dogs, cats, especially poultry = “Chicken rotisserie”
- **Transmission** – fecal oral, primarily from poultry
- **Pathogenesis** – low infectious dose (as few as 500) as all that is needed; bacteria is acid resistant so can pass through the stomach easily; it invades the mucosa of the colon (“bears invading the cooler”), and destroys the mucosal surfaces, causing an inflammatory diarrhea; it rarely causes septicemia
- **Disease** – gastroenteritis; common cause of infectious diarrhea worldwide, but most common in the US; causes 10 or more bloody diarrhea a day = “red stools around the campfire”; abdominal pain, fever, malaise, nausea, and vomiting
 - **Complications include reactive arthritis** (“camping guy slapping his knee as reaction”) and **Guillain-Barre syndrome**, which is caused by serotype O:19, antigenic cross-reactivity between Campy oligosaccharides and glycosphingolipids on neural tissue – causes an ascending paralysis from demyelination of neurons = “Guy and the Bears sounds like Guillaume Barre, and the bears playing and tripping over sausage links represents GBS starting in the LE and ascending in its demyelination process”.
- **Treatment** – disease is self-limiting within 3-5 days, mostly supportive via fluid and electrolyte replacement (“camping guy drinking out of water bottle”); bacteria is penicillin resistant, so erythromycin and fluoroquinolones can help





GENUS: VIBRIO “Colonel Cholera’s Base cAMP”

Setting in SE Asia as Cholera is endemic in developing countries

Genus features:

- **Gram-, curved/comma-shaped rods with polar flagella** = “comma shaped mustache on the colonel” and “curved raft in the river that is red (for negative) that has rope (flagella)”
- **Oxidase positive** = “blue ring on colonel”
- **Vibrionaceae family**
- **Grows in alkaline environments (does not particularly like acidic environments)** = “Base in the title” and “drinking lemon-water” for acid-labile
- **Grows on thiosulfate citrate bile salt sucrose medium (TCBS) and turns orange** – ferments sucrose
- ***Vibrio parahaemolyticus* and *Vibrio vulnificus*:** both are transmitted by consumption of raw seafood and cause watery diarrhea as well (“oysters next to the colonel”); *V. vulnificus* can also cause rapidly spreading cellulitis that may be difficult to treat.
- ***Vibrio cholera* (O1 serotype)** has been subdivided into an El tor subtype and a cholera subtype...
 - **Distinguishing Features** – “shooting star” motility inactivated by specific serum
 - **Reservoir** – human colon; can be transiently carried by shellfish contaminated in water, but not true reservoirs; human carriage may persist after untreated infection for months after infection, but permanent carrier state is rare
 - **Transmission** – fecal-oral spread = “outhouse over the river”; transmission requires a high dose ($>10^7$ organisms) because cholera is sensitive to acid; many will die, but the few will infect
 - **Pathogenesis** – motility, mucinase, and toxin coregulated pili (TCP) aid in attachment to the intestinal mucosa (“represented by the Base cAMP map of the river which looks like the small intestines; the cholera raft attaches to the dock (mucosa) by its rope (flagella), indicating that it does not invade the mucosa”). **There the enterotoxin cholera toxin (similar to ETEC’s LT toxin), activates Gs alpha (“Gs tear gas canisters”) by ADP ribosylation, which activates adenylate cyclase, which increases cAMP (“cAMP map”), causing an efflux of Cl^- and water into the small intestines; this leads to rice water diarrhea and tremendous fluid loss - up to 20 L lost (“river of slightly brown water extending out into rice paddy fields) - and hypovolemic shock is a major complication if not treated.**
 - **Treatment** – fluid and electrolyte replacement by IV = “colonel is drinking bottled water”; antibiotics doxycycline or ciprofloxacin can shorten disease and reduce carriage; resistance to tetracycline has been reported
 - **Prevention** – proper sanitation; new vaccine

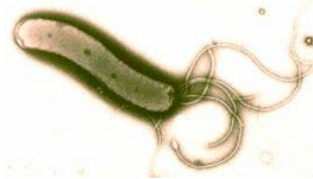




sketchymicro

www.sketchymicro.com

GENUS: **HELICOPACTER**; SPECIES: **PYLORI** “Helicopter Pilot”



- **General features:** Gram-, spiral gastric bacilli, motile with flagella (“propellers”), curve shaped (“curly mustache”), oxidase+ (“blue ring”), microaerophilic, 37°C growth, and urease+ (“ammonium spray bottle”)
- **Reservoir:** humans, generally in the stomach near the pylorus
- **Transmission:** fecal-oral or oral-oral
- **Pathogenesis:** the urease creates an ammonium cloud that neutralizes the stomach acid, allowing its survival in the stomach acid during transit to the border; mucinase aids in penetration of mucous layer (rapid shift down to neutral as it penetrates). It invades into the stomach lining where the pH is neutral. Inflammation is prominent. There are two biotypes (I and II); type I produces vacuolating cytotoxin.
- **Diseases:** chronic gastritis and duodenal ulcers (>95%) = “bullet holes in the helicopter for ulcers” and “gas pump shaped as duodenum leaking”
 - Associated with several forms of stomach cancer (gastric adenocarcinoma) that does not resolve with treatment of *H. pylori* = “crab sign signifying cancer”; now classed by WHO as a type I carcinogen
 - Also associated with gastric mucosa-associated lymphoid tissue lymphoma (MALT-oma or B-cell lymphoma) that will resolve with treatment of *H. pylori* = “pile of tissues next to the pilot that is covered with mucus – mucus associated lymphoid tissues”
- **Diagnosis:** biopsy with culture; histology with Giemsa or silver stain is gold standard; Urease breath test to screen – ¹³C-urea is swallowed and broken down into ammonia + ¹³C-CO₂, which is exhaled and detected
- **Treatment:** treatment with triple therapy of Omeprazole, a PPI (“a proton-bomb inhibiting the proton gasoline pump”), amoxicillin (“ammo box”), and clarithromycin (“a macrolide crow on a keep clear sign”); treatment is prolonged for 10-14 days, up to 3 weeks. Quadruple therapy by adding bismuth is used where clarithromycin resistance is >15% (PPI + bismuth + 2 antibiotics – metronidazole and tetracycline, eg)

PSEUDOMONAS AERUGINOSA “The Suitors of Pseudo Mona”

- **General Features:** Gram- rod (“red hues and red tub shaped as rod”), oxidase+ (“Mona wearing blue ring”), catalase+ (“cat!”), encapsulated (“jar glass covering the candy”), aerobic and nonfermenting (“servant stoking the fire with an air bellow”), produces blue-green pigment from pyocyanin, pyoverdinin, and fluorescein (“blue-green residue on the bath tub”), produces a grape-like odor (“Mona eating grapes”), produces a slime layer, non-lactose fermenting colonies on EMB or MacConkey, and biofilm;
- **Reservoir:** ubiquitous in water (“water in the tub”)
- **Transmission:** water aerosols, raw vegetables, flowers
- **Pathogenesis:** Endotoxin causes inflammation in tissues and gram- shock in septicemia; Exotoxin A ADP ribosylates eEF-2, inhibiting protein synthesis, just like the diphtheria toxin (“same symbol as Diphtheria toxin – a suitor with a Bow playing the elongating Accordion”), Liver is the primary target, the Capsule/ slime layer allows formation of pulmonary microcolonies and is difficult to remove by phagocytosis
- **Diseases:**
 - In Healthy people: is a transient GI tract colonization, produces loose stools; can cause “Hot Tub Folliculitis” or pruritic popular pustule folliculitis, associated with people using under-chlorinated hot tubs (“scene is set with Mona in a hot tub”); can also cause eye ulcers from trauma, coma, or prolonged contact wear
 - Burn Patients: the GI tract colonization can end up on the skin leading to colonization of eschar causing cellulitis (blue-green pus) and septicemia (“Maid stoking the fire is on fire!”)
 - In Neutropenic patients: can cause pneumonia and septicemias; often a superinfection while on antibiotics
 - Chronic granulomatous disease (CGD): because *pseudomonas* is catalase+; can lead to pneumonias and septicemias
 - Otitis Externa (aka swimmer’s ear) – in swimmers, diabetics, and those with pierced ears (“maid listening to ear trumpet”)
 - Osteomyelitis: in IV drug users and diabetics (“fish bones sitting next to a mortar and pestle and a jar of candy”)
 - Septicemias: with fever, shock and skin lesions that are black with a necrotic center and erythematous margin, called ecthyma gangrenosum (“Dalmatian dog with black spots”)
 - Catheterized patients get UTIs (“chamber pot next to a nurse that indicates a nosocomial infection”)
 - Cystic Fibrosis patients are easily susceptible to nosocomial pneumonia and respiratory failure due to early pulmonary colonization and recurrent pneumonias; always from the high slime-producing strains (“nurse pouring Cl⁻ - indicating mutated channel in CF – coughing”)
- **Diagnosis:** gram stain and culture
- **Treatment:** an antipseudomonal penicillin, piperacillin (“suitor playing the pipe”), and an aminoglycoside and fluoroquinolones (“suitor holding a flower and a scythe”)
- **Prevention:** pasteurization or disinfection of water-related equipment, hand washing; prompt removal of catheters; no flowers or raw vegetables in burn units!





PROTEUS MIRABILIS/ vulgaris “The God of the Public Restroom”

- **General Features:** Gram- rod (“red hues of the bathroom scenery”), **enterobacteriaceae**, **peritrichous flagella** – **highly motile with “swarming motility”** (“Proteus is an octopus god with many moving tentacles”), **urease+** (“Proteus is holding the ammonia bottle”), **facultative anaerobe**, **fish-smelling odor** (“fish on the bathroom floor”)
- **Reservoir:** human colon and environment (water and soil)
- **Transmission:** endogenous
- **Pathogenesis:** Urease raises the urine pH to cause kidney stones (“Proteus is throwing a stone at the man peeing in the stall where Proteus is spraying his ammonia”); **the stones are referred to as staghorn renal calculi for their shape** (“Proteus’ crown has staghorns”); **motility may aid entry into the bladder; endotoxin causes fever and shock when septicemia occurs**
- **Diseases:** UTIs (“guy peeing in the bathroom stall”) and **septicemia**
- **Diagnosis:** culture of blood or urine for **lactose-negative organisms with swarming motility**
- **Treatment:** **Sulfonamides** (“rotting eggs on the ground”), **fluoroquinolones**, **TMP-SMX**, or **third-generation cephalosporin** for **uncomplicated UTIs**; **remove stones if present**
- **Prevention:** promptly remove urinary tract catheters



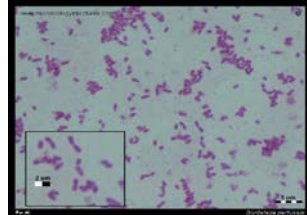
VICTORY! 100 DAY'S WAR!



sketchymicro
www.sketchymicro.com

BORDETELLA PERTUSSIS “Board and Care”

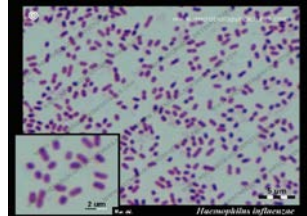
- **General Features:** small gram- rod, an encapsulated organism, a strict aerobe
- **Reservoir:** vaccinated human – vaccine protected us when young, but immunity is lost as we age
- **Transmission:** respiratory droplets (“one of the crows holding its beak”)
- **Pathogenesis:**
 - *B. pertussis* is a mucosal surface pathogen
 - Attachment to nasopharyngeal ciliated epithelial cells is via filamentous hemagglutinin which causes ciliary stasis (“streamers around the room”), and pertussis toxin found on the outer membrane also aids in attachment
 - Toxins damage the respiratory epithelium:
 - Adenylate cyclase toxin impairs leukocyte chemotaxis, which inhibits phagocytosis and causes local edema; it acts like the Anthracis EF toxin (“EF Viking shield on the wall”)
 - Tracheal cytotoxin interferes with ciliary action and kills the ciliated cells (“tractor on the midline path in the window cleaving the cilia-like grass”)
 - Pertussis toxin has A and B component, an OM protein toxin: it ADP ribosylates G_i (“there is a bow tie on our disabled G.I.”), inhibiting the negative regulator of adenylate cyclase causing an increase in cAMP (“camp in the window”); this interferes with transfer of signals from cell surface to intracellular mediator system leading to lymphocytosis (“war veteran holding white-spherical popcorn overflowing the container”), Islet-activation causing hypoglycemia, blocking of immune effector cells and decreased chemotaxis, and increased histamine sensitivity
- **Stages of Whooping Cough (Pertussis)**
 - Incubation (7-10 days)
 - Catarrhal (1-2 weeks): rhinorrhea, malaise, sneezing, anorexia, much like a “cold”; this is the best time to culture
 - Paroxysmal (2-4 weeks): repetitive cough with whoops upon inspiration (“war veteran coughing vigorously and holding an air horn that whoops”), vomiting, leukocytosis
 - Convalescent (1-3 months or longer): sometimes called the “100 Day Cough” (“‘Victory! 100 Day’s War’ banner”); presents as a diminished paroxysmal cough with development of secondary complications (pneumonia, seizures, and encephalopathy)
- **Diagnosis:** Regan-Lowe or Bordet-Gengou media; either direct cough plates or nasopharyngeal cultures; difficult to culture from the middle of paroxysmal stage on so use serology; direct immunofluorescence (DFA) on nasopharyngeal smear; PCR and serologic tests
- **Treatment:** supportive care; hospitalization if <6 months old; erythromycin for 14 days including all household contacts; macrolides can also be given (“crows perched on the window”)
- **Prevention:** vaccine is DTaP – the aP for acellular pertussis (“an old ‘cellular phone’ next to a vaccine syringe”), which is the filamentous hemagglutinin plus pertussis toxoid; immunity wanes 5-7 years; babies are born with little or no immunity (IgA) from the mother





HAEMOPHILUS INFLUENZAE “Phyllis’s Chocolate Covered Cherries”

- **General Features:** Gram- (“red hues”), pleomorphic – coccobacilli – rods (“candy dispensing machine shape and the candy within shaped as coccobacilli”), requires both growth factors X – hematin (“10C sign”) and factor V – NAD (“5C or a Nickle for nicotinamide”) for growth on chocolate agar (“store cells chocolate...”); grows near *S. aureus* on blood agar = “satellite” phenomenon; encapsulated but only in type B invasive form
- **Reservoir:** human nasopharynx
- **Transmission:** respiratory droplets, shared toys, aerosols (“Phyllis is holding a spray can over her glass cabinet of chocolates”)
- **Pathogenesis:** Polysaccharide capsule is Type B capsule of polyribitol phosphate, the most important virulence capsule (“glass capsule with a bee flying over it”); capsule important in diagnosis, antigen screen on CSF with latex particle agglutination – serotype all isolates by quelling; IgA protease is a mucosal colonizing factor
- **Diseases:**
 - Meningitis only from the Type B encapsulated form (“kid in astronaut costume with meningitis hat is pointing at the bee flying over the glass capsule”); epidemic in unvaccinated children ages 3 months to 2 years; after maternal antibody has waned and before the immune response of the child is adequate; was the most common cause of meningitis in 1-5 yr old children up to 1990; still a problem if child is <2 years and not vaccinated, typical case describes immigrant or immunizations unknown
 - Otitis Media (“kid in knight outfit plugging his ears”); usually nontypeable strains
 - Bronchitis: exacerbations of acute bronchitis in smokers with COPD
 - Pneumonia: in 1-24 month old infants, but rare in vaccinated children; occurs also in smokers
 - Epiglottitis: presents with inspiratory stridor, drooling, and inflamed or cherry red epiglottis (“Phyllis selling Chocolate covered cherries, and the kid in knight costume is screaming, with his epiglottis out, drooling, and holding an ice cream with a cherry that has fallen off”); rare in vaccinated children, so seen in unvaccinated toddlers; was the major causal agent
 - Sickie Cell or asplenic patients have an increased risk of infection (“kids in knights costumes carrying sickies”)
- **Diagnosis:** Blood or CSF culture on chocolate agar, PCR, antigen detection of capsule on latex particle agglutination
- **Treatment:** cefotaxime or ceftriaxone (“kids in knight costumes carrying 3 axes”) for empirical therapy of meningitis; check nasal carriage before releasing; use rifampin as prophylaxis for close contacts (“healthy kid in cowboy costume carrying rifle”), Rifampin also reduces oropharynx colonization and prevents meningitis in unvaccinated <2 years of age, or for those if still colonized
- **Prevention:** Vaccination is effective to prevent the Type B disease; it is a polyribitol capsule conjugated to the diphtheria toxoid or *N. meningitidis* outer membrane protein, making it a T-cell dependent vaccine – vaccinate between 2-18 months: specifically at 2, 4, 6 months with booster at 15 months; 95% effective (“sign reads ‘Special! Sugar DIPped for \$2.18”)





LEGIONELLA PNEUMOPHILA “The S.S. Cysteine Joins the Legion”

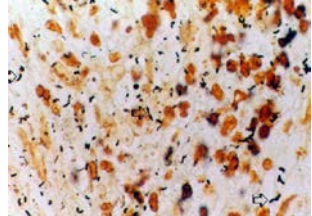
- **General Features:** gram-, but stains poorly so must be silver stained to be visualized (“a red and rusty ship that is painted silver”), is fastidious requiring increased iron and cysteine for laboratory culture in a charcoal yeast extract (“an iron anchor next to the S.S. Cysteine name of the ship and heaping piles of coal”); facultative intracellular, water organisms
- **Reservoir:** rivers, streams, amoebae; air conditioning water cooling tanks
- **Transmission:** aerosols from contaminated air-conditioning, not from human-to-human transmission
- **Predisposing Factors:** smokers over 55 years (“sailor smoking”) with high alcohol intake; also immunosuppressed patients, i.e. renal transplant patients
- **Pathogenesis:** a facultative intracellular pathogen with an endotoxin
- **Diseases:**
 - Legionnaires disease, an atypical pneumonia associated with air-conditioning systems that are now routinely decontaminated. Is characterized by pneumonia that is typically unilobar (“smoking sailor is holding the ship’s blue print that looks like chest x-ray with unilobar consolidation”); hyponatremia (“sailor moving piles of salt onto ship, but spilling”), mental confusion (“a sailor clutching his head”), and diarrhea – but no *Legionella* is in the GI tract (“brown paint spilled onto another sailor’s pants”); also presents with high fever (“sailor scooping coals into furnace sweating profusely”)
 - Pontiac Fever (“the old Pontiac car with hood open and steaming”), is self-limiting and characterized by pneumonitis, but no fatalities
- **Diagnosis:** a urine antigen test (“sailor urinating into the water”), direct fluorescent antibody – DFA – on biopsy, and seen on Dieterle silver stain (“silver-painted ship”); fourfold increase in antibody
- **Treatment:** fluoroquinolone (“sailor handing flower to girl”) or macrolides (“crows present at scene”), azithromycin or erythromycin, with rifampin for immunocompromised patients; drugs must penetrate human cells
- **Prevention:** routine decontamination of air-conditioner cooling tanks

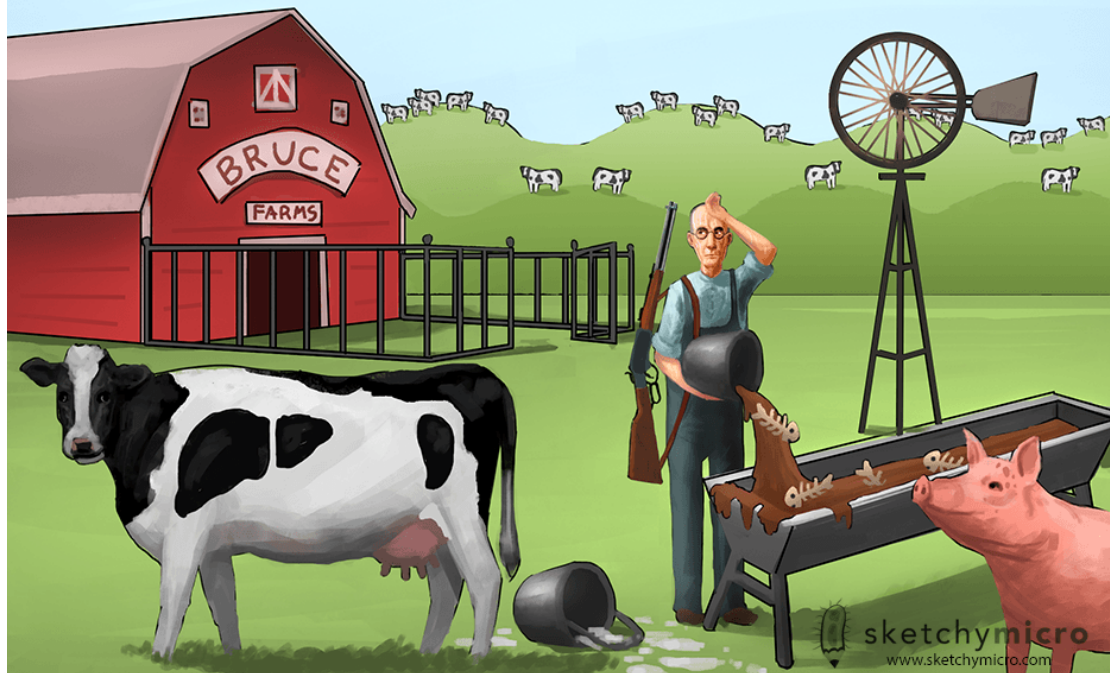




BARTONELLA HENSELAE “Bart the Leopard”

- **General Features:** Gram- rods (“Bart the leopard cat is sitting on a red pillow”); use **Warthin-Starry stain, a type of silver stain, to visualize** (“Van Gogh’s starry night backdrop with silver hues”)
- **Reservoir:** cats and dogs, especially cats (“Bart the leopard cat”)
- **Transmission:** bites, fleas, scratches (“our human characters both have scratches on their hands”)
- **Diseases:**
 - **Cat Scratch Fever:** produces fever in immunocompetent patients and can involve regional lymphadenopathy, especially in the axilla (“Immunocompetent princess wearing a dress with sleeves bunched up into balls under her axilla”)
 - **Bacillary angiomatosis:** occurs in immunocompromised individuals, i.e. those with HIV or AIDS; they develop raised red vascular lesions (“man holding the immunocompromised cane wearing clothing with raised red spots”)
- **Diagnosis:** Warthin-Starry stain
- **Treatment:** Azithromycin or other macrolides for both diseases (“crows flying off”), doxycycline to treat bacillary angiomatosis (“bicycle wheel symbol”)

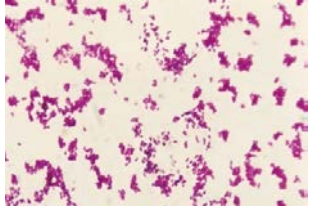


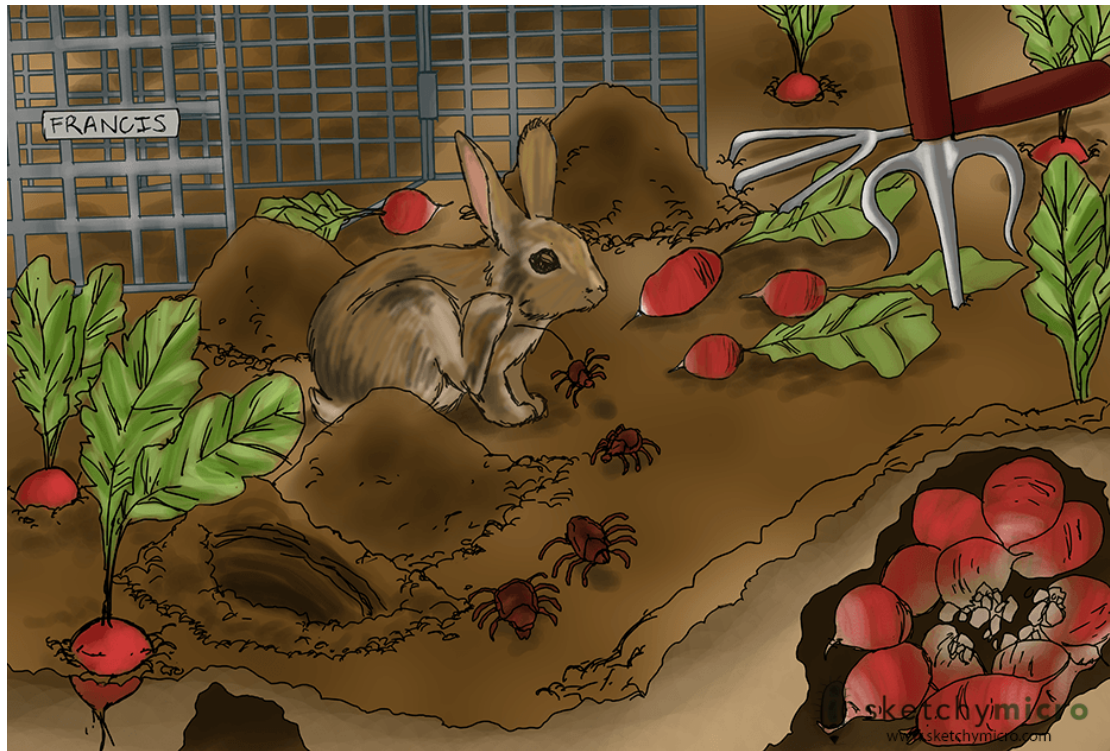


sketchymicro
www.sketchymicro.com

GENUS: BRUCELLA “Bruce Farms”

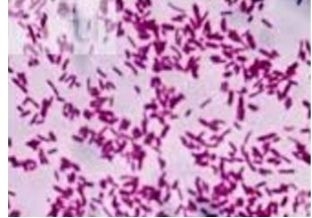
- **General Features:** small, gram- rods (“red barn house”), aerobic, facultative intracellular (“open gate in front of barn”), zoonosis, potential biowarfare agent
- **Species of Medical Importance and associated reservoir:** *Brucella abortus* (cattle), *Brucella melitensis* (goats), *Brucella suis* (pigs)
- **Reservoir:** domestic livestock (“the cattle and pig”)
- **Transmission:** unpasteurized dairy products (“milk bucket of unpasteurized milk”) – California and Texas have the highest number of cases; most associated with travel to Mexico. Also direct contact with animal – i.e. vets, working in a slaughterhouse, or farmers (“our farmer Bruce”)
- **Pathogenesis:** Endotoxin; as a facultative intracellular parasite, it localizes in cells of the reticuloendothelial system, which can cause septicemia and a granulomatous response with central necrosis, ultimately causing splenomegaly, hepatomegaly, and lymphadenopathy (“cow spots are shaped like liver and spleen”)
- **Disease:** brucellosis or undulant fever (“undulating hills in backdrop”), characterized by acute septicemias, fever often in the evening and influenza-like symptoms of arthralgia, anorexia, myalgia, and back pain, and profuse sweating (“farmer is sweating profusely and is anorexic thin”); the chronic form usually presents in older people with cyclic bouts of depression and sweating, fever is rare, ocular complications can occur as well as chronic fatigue and osteomyelitis (“fish bones in the pig food trough”)
- **Diagnosis:** culture is hazardous; serum agglutination test with fourfold increase in titer – antibodies against *Brucella* >1:160 is considered positive
- **Treatment:** for adults: rifampin (“rifle for the sick farmer”) and doxycycline (“windmill with bicycle wheel”) minimum for 6 weeks; for children: rifampin and cotrimoxazole
- **Prevention:** vaccinate cattle; pasteurize the milk, especially goat milk





FRANCISELLA TULARENSIS “Francis the Rabbit”

- **General Features:** small gram- rod or coccobacilli (“red radishes kind of look like the shape”), a **facultative intracellular pathogen** (“rabbit cage door is open”), is a **potential biowarfare agent** as it can be **aerosolized**, is **acquired from animals – zoonosis**
- **Reservoir:** many species of wild animals, but especially **rabbits** (“the main character Francis is a rabbit”), **deer, and rodents**
- **Transmission and Pathogenesis:** A tick bite from *Dermacentor* ticks (“Francis is scratching the ticks off”) causes a **ulceroglandular disease** where the bacteria gets into an **ulcer** (“the rabbit hole”) and **enters the lymphatic system to cause a granulomatous response** (“radishes in the rabbit hole are rotting in the center”), leading to **regional lymphadenopathy** (“rotting radishes pushing dirt up and creating dirt piles”); can also be caused by **traumatic implantation while skinning rabbits**; **aerosols from skinning rabbits causes pneumonias**; and **ingestion of undercooked, infected meat or contaminated water produces a typhoidal tularemia**
- **Disease:** Tularemia, aka **Rabbit Fever**, is endemic in every state of the US, but highest in **Arkansas and Missouri**; is characterized by **fever, ulcer at the infection site, and regional lymph node enlargement and necrosis**
- **Diagnosis:** Serodiagnosis – culture is hazardous; DFA
- **Treatment:** Streptomycin, an aminoglycoside (“the scythe-shaped gardening tool”)
- **Prevention:** protect against tick bites, wear gloves while **butchering rabbits**; a live, attenuated vaccine is available for persons in high risk (those with outdoor jobs, vets, etc)





sketchymicro

www.sketchymicro.com

PASTEURELLA MULTOCIDA “Louis Pasteur’s Lab”

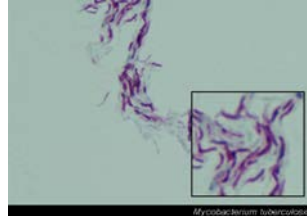
- **General Features:** small gram- rods, facultative anaerobe, catalase+ (“cat!”), oxidase+ (“Louis’ blue ring”), encapsulated (“glass capsule”)
- **Reservoir:** mouths of many animals, especially cats and dogs (“the cat and dog in the scene”)
- **Transmission:** animal bites, particularly from cats (“dog bit Louis”)
- **Pathogenesis:** endotoxin, capsule; spreads rapidly within skin, no exotoxins known
- **Disease:** cellulitis with lymphadenitis within 24 hours of bite (“dog bite caused an erythematous wound on Louis”); wound infection rapidly spreads, frequently a polymicrobial infection; can cause osteomyelitis (“Louis is holding fish bones”)
- **Diagnosis:** rarely cultured because routine prophylaxis is common; however, bacteria grows on 50% sheep blood agar (“sheep’s blood vials on shelves”); also demonstrates safety-pin, bipolar staining (“safety pin on Louis’ white lab coat”)
- **Treatment:** Penicillin (“Louis’ pencils”); amoxicillin and clavulanate combination for cat bites; bacteria is resistant to macrolides
- **Prevention:** amoxicillin and clavulanate is standard prophylaxis and treatment for most bites (human included), along with thorough cleaning





MYCOBACTERIUM TUBERCULOSIS “Shootout at the TB Corral”

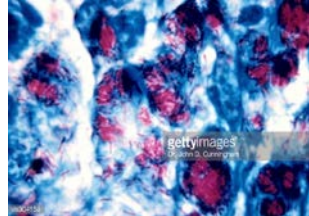
- **General Features:** Auramine-rhodamine staining bacilli (fluorescent apple green); no antibody involved (sensitive but not specific); acid fast – mycolic acids of 2-chain fatty acids (“tassels of cowboy’s shawl and chaps”) – takes up carbol fuchsin stain (“cowboy drawing fuchsia-colored gun from holster fast”); aerobic (“We Carry Bellows!” sign and symbol”), slow growing on Lowenstein-Jensen medium (“Lowenstein General Store backdrop”); new culture systems of broths with palmitic acid grows faster; produces niacin; produces a heat-sensitive catalase (a standard catalase test at 68°C is negative; active at body temperature)
- **Reservoir:** human lungs; **Transmission:** respiratory droplets and recirculated air, as in on airplanes
- **Pathogenesis:**
 - Facultative intracellular organism – most important virulence factor
 - Sulfatides (sulfolipids in cell envelope) inhibit phagosome-lysosome fusion, allowing intracellular survival – if fusion occurs, waxy nature of cell envelop reduces killing effect (“spurs on cowboy represent sulfatides; separate and different sized dust clouds behind cowboy represent phagosome-lysosome inability to fuse; bacteria survives in macrophages represented by the Mφ cage”)
 - Cord factor (trehalose dimycolate) causes serpentine growth in vitro (“lasso wrapping around the driver of the Mφ cage”); inhibits leukocyte migration and disrupts mitochondrial respiration and oxidative phosphorylation
 - Tuberculin (surface protein) along with the mycolic acid cause a delayed hypersensitivity – type IV – and cell mediated immunity (CMI); granulomas and caseation are mediated by the CMI; no exotoxins or endotoxin – damage is done by the immune system
- **Diseases:**
 - Primary pulmonary tuberculosis: affects the lower or middle lobes – organisms replicate in naïve alveolar macrophages, killing the macrophages until CMI is set up (Ghon focus); macrophages then transport the bacilli to the regional lymph node (Ghon Complex) and most people heal without disease, termed the Healed Latent Infection phase, which is often associated with children, where fibrosis occurs and the disease becomes latent (“represented by sleeping child in a burlap sac”) (“cactus on left drawn to represent the lobes of the lungs with bullet holes through the middle lobe; red cactus fruit in the region of the hilum represent hilar lymph node involvement; together – the hilar lymphadenopathy and peripheral granulomatous lesion in the middle lung lobe make the Ghon Complex represented by the Gun Complex store behind this cactus”); organisms that are walled off within the Ghon complex remain viable unless treated – this causes caseating necrosis in the center and the Tubars (bacteria) resides in these necrotic macrophages (“presented by the broken Mφ carts, one with potatoes within”)
 - Reactivational tuberculosis: erosion of granulomas into airways with high oxygen content later in life under conditions of reduced T-cell immunity – or neutralized TNFα – leads to mycobacterial replication and disease symptoms (“guy tied up with the TNF barrel to illustrate neutralized TNFα”); affects upper lobes primarily (“2nd cactus on the right with bullet holes in the upper lobes”); a complex disease with the potential of infecting any organ system and may disseminate to become Miliary TB, which is the seeding of organs with TB (“millet seeds found in second damaged cart spilling out and getting everywhere”); symptoms of reactivation include coughing, night sweats, and hemoptysis (“man in Mφ cage sweating and coughing blood”)
 - Potts Disease is where TB infects the bones and spinal column (“stack of pots to represent vertebral bodies cracked and damaged”); for CNS involvement, TB can cause meningitis or a tuberculoma cavity lesion (“man next to the reactivation cactus with his hat shot off to represent CNS involvement”)
- **Diagnosis:** Microscopy of sputum; PPD skin test (Mantoux) measure zone of induration at 48-72 hours; positive if >5mm in HIV+ or anyone with recent TB exposure – AIDS patients have reduced ability to mount skin test, >10mm in high risk populations like IV drug users, people living in poverty, or immigrants from high TB areas, and >15mm in low risk populations – a positive skin test indicates only exposure but not necessarily active disease (“shovel into a lump of dirt represents positive test”); quantiferon-TB Gold Test measures interferon-gamma production when leukocytes exposed to TB antigens;
- **Treatment:** multiple drugs are critical to treat infection; standard short-term therapy for uncomplicated pulmonary TB for first 2 months is RIPE (“RIPE written on cart with potatoes”): Rifampin + Isoniazid + Pyrazinamide + Ethambutol; next 4 months is just Rifampin and Isoniazid (“The RI in RIPE is highlighted”); ethambutol or streptomycin are added for drug-resistant cases
- **Prevention:** Rifampin (“man holding the rifle”) and Isoniazid is taken for 9 months to prevent TB in persons with infection but no clinical symptoms; a Bacille Calmette-Guerin (BCG) vaccine containing live, attenuated organisms may prevent disseminated disease, but is not used in the use – but can cause a positive PPD test! (“BCG syringe in +PPD symbol of shovel in dirt”); UV lights or HEPA filters used to treat potentially contaminated air.





MYCOBACTERIUM LEPRAE “The Good, the Bad, and the Lion-Faced”

- **General Features:** acid fast rods seen in punch biopsy (“same acid fast gun slinger with fuchsia gun and tassels”); an obligate intracellular parasite that cannot be cultured in vitro; optimal growth is at less than body temperature (“scene takes place in winter time with snow on the ground”)
- **Reservoir:** human mucosa, skin, and nerves are only significant ones; some infected armadillos in Texas and Louisiana (“Armadillo Co. Jail is scene and there’s an armadillo in the scene”)
- **Transmission:** nasal discharge or human-to-human contact from untreated lepromatous leprosy patients (“2nd prisoner representing lepromatous leprosy reaching out to the cowboy”)
- **Pathogenesis:** obligate intracellular parasite; cooler parts of the body like the extensor surfaces of extremities, skin, mucous membranes, and peripheral nerves are most affected
- **Disease:** leprosy: a continuum of disease, which usually starts out with an indeterminate stage called borderline. The two extreme forms are:



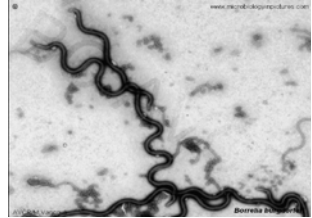
	Tuberculoid	Lepromatous
Cell mediated immunity:	Strong Cell-Mediated Immune response (TH1) = “jail cell #1”	Weak CMI, promotes humoral response (TH2) = “jail cell #2, 2 nd prisoner is smiling
Lepromin skin test	+ Positive	- negative
Number of organisms in tissue	Low	High (foam cells totally filled)
Damage from	Immune response (CMI killing infected cells); granuloma formation containing bacteria within macrophages (“prisoner in Cell #1 behind bars”), leads to nerve enlargement and damage, causing loss of sensation, burns, and trauma	Large number of intracellular organisms; nerve damage from overgrowth of bacteria in cells as bacteria is unable to be contained by the macrophages (“2 nd prisoner escaping from jail cell”); leads to loss of sensation, burns, and trauma
Number of Lesions and other Symptoms	Fewer lesions, macular, nerve enlargement and paresthesias, well demarcated hairless lesions on skin (“prisoner in cell#1 has bald spot”)	Numerous poorly demarcated, raised lesions becoming nodular that are all over, but especially on extensor surfaces of extremities (“pink patches on 2 nd prisoner”); loss of eyebrows, destruction of nasal septum, and general facial deformities called Leonine Facies (“cowboy with lion-face bandana”), symmetric glove and stocking neuropathy and paresthesia (“glove and slippers on 2 nd prisoner”)

- **Diagnosis:** punch biopsy or nasal scrapings with acid fast stain; Lepromin skin test is positive in the tuberculoid but not lepromatous form (“shovel entering mound of dirt next to Jail Cell #1”), no cultures
- **Treatment:** multiple drug therapy with dapsone and rifampin for the Tuberculoid form (“Deputy with deputy badge representing dapsone carrying rifampin rifle by Jail cell #1”); add clofazimine for lepromatous form (“another deputy with rifle holding cloth next to cloth rope for clofazimine”)
- **Prevention:** dapsone for close family contacts



BORRELIA BURGDORFERI “The Bows and Arrows of Borrelia”

- **General Features:** larger spirochetes (“a split arrow spiral shaped”), gram-, microaerophilic, difficult to culture
- **Reservoir:** white-footed mice are hosts of tick larvae (“mouse in scene”), and white-tailed deer are obligatory host of adult ticks (“deer in scene”)
- **Transmission:** By *Ixodes* deer ticks and nymphs (“Tick sign and Robin of Ixodes is main character”); worldwide but in 3 main areas in the US – *Ixodes scapularis* is found in the Northeast (“the Northeast archery competition”) and Midwest like Wisconsin; *Ixodes pacificus* is found on the West Coast – typically infections occur in the late spring, early summer with people go hiking in dense forests (“forest scenery”)
- **Pathogenesis:** *B. burgdorferi* invades skin and spreads via the bloodstream to involve primarily the heart, joints, and CNS; migratory arthritis is caused by immune complexes
- **Disease:** Lyme disease (“knights wearing lime green uniforms”) - #1 tick-borne disease in the US; three stages:
 - **Stage 1:** early localized, 3 days – 1 month; presents with target rash (“bull’s eye under stage 1”) and flu-like symptoms (“Sir Wright by Stage 1 is sweating, looking ill”)
 - **Stage 2:** early disseminated, days – weeks later, organism spreads hematogenously; presents with fatigue, chills, fever, HA, muscle and joint pain, swollen lymph nodes, secondary annular skin lesions, heart block caused by myocarditis (“man holding shield with heart on it under stage 2”) and bilateral bell’s palsy (“two bells next to guy’s face”)
 - **Stage 3:** late persistent, months – years; presents with HA, meningitis and encephalopathy (“swinging mannequin with arrow through its head under stage 3 and Sir Giemsa by stage 3 is confused”), extreme fatigue, conjunctivitis, palpitations, arrhythmias, myocarditis, pericarditis, migratory arthritis – most common in the knees (“swinging straw mannequin with arrow through its knee”)
- **Diagnosis:** serodiagnosis by ELISA – negative early; Western blot for confirmation; stains on Wright’s and Giemsa stain (“Sir Wright and Sir Giemsa represent”)
- **Treatment:** Doxycycline (“Robin riding a unicycle”), amoxicillin, or azithromycin/ clarithromycin for stage 1 of disease; ceftriaxone (“Robin’s shield has 3 axes symbol”) for stage 2 of disease; doxycycline or ceftriaxone for the arthritis
- **Prevention:** DEET to avoid tick bites; a vaccine – OspA flagellar antigen – is available but not used in the US





LEPTOSPIRA INTERROGANS “The Surfer’s Oasis”

- **General Features:** spirochetes, thin with hooks, question mark-shaped (“question mark symbol on surf board with spiral strap to surf dude”), too thin to visualize, but gram- cell envelope
- **Reservoir:** wild and domestic animals (zoonosis)
- **Transmission:** contact with animal urine in water (“surfer riding in on yellow tide and waters”). Organism penetrates mucous membranes or enters small breaks in epidermis. In US, via dog, livestock, and rat urine through contaminated recreational waters (i.e. jet skiers) or occupational exposure (i.e. sewer workers). Hawaii has highest incidence (“scene is set in Hawaii with main character surfing”)
- **Pathogenesis:** no toxins or virulence factors known
- **Disease:** leptospirosis (swineherd’s disease or swamp or mud fever); presents as influenza-like disease (“surfer sweating profusely”) and GI tract symptoms, Weil Disease (“Whale breaching the water”), as well as conjunctival suffusion (“Surfer rubbing eyes and wearing red-tainted sunglasses”); can progress on to affect multiple organs by hematogenous spread (“red tubes that look like RBCs”), especially the liver causing hepatitis and jaundice (“yellow surf suit”) and renal failure (“kidney shaped rubber dingy”)
- **Diagnosis:** serodiagnosis, agglutination test; culture via blood, CSF, or urine available in few labs; dark field microscopy insensitive
- **Treatment:** penicillin G or doxycycline
- **Prevention:** doxycycline effective for short term exposure; vaccination of domestic livestock and pets; rat control





TREPONEMA PALLIDUM “Pallidum Observatory”

- **General Features:** thin spirochete (“spiral galaxy in corner and spiral staircase”), poorly visible on gram stain but has gram- envelope, outer membrane has endotoxin-like lipids, axial filaments = endoflagella = periplasmic flagella allows for motility, cannot culture in clinical lab so serodiagnosis, is an obligate pathogen, but not intracellular
- **Reservoir:** human genital tract; **Transmission:** sexually or across the placenta
- **Pathogenesis:** Disease is characterized by endarteritis resulting in lesions; strong tendency to chronicity
- **Diagnosis:** Visualized by immunofluorescence or dark-field microscopy (“Galaxy’s name is Darkfield; researcher using large telescope”); serology is important – two types of antibodies:

1. Ab binds to cardiolipin: an antigen found in mammalian mitochondrial membranes and in treponemes; a cheap source of antigen is cow heart, which is used in screening tests; very sensitive in primary, except early, and secondary syphilis – titer may decline in tertiary and with treatment; but not specific – must confirm with FTA-ABS. Examples include Venereal Disease Research Lab (VDRL) (“Video Display Research Lab”), Rapid plasma Reagin (RPR), Automated Reagin Test (ART), or Recombinant Antigen Test (ICE)
2. Specific tests for treponemal antibody are more expensive; earliest antibodies bind to spirochetes: these tests are more specific and positive earlier; usually remain positive for life, but positive in patients with other treponemal diseases (bejel) and may be positive in Mono, RF, Lupus, Leprosy, Lyme, and Drug users. The most widely used is Fluorescent Treponemal Antibody-Absorption (FTA-ABS) (“Field Telescope A-AB sign”) or Treponema pallidum microhemagglutination (MHA-TP)

- **Treatment:** benzathine penicillin (“purple pencils”) is the long-acting form for primary and secondary syphilis; penicillin G for congenital and late syphilis; Jarisch-Herxheimer reaction (“the Jarisch Herxheimer Comet Viewing sign”) starts generally during the first 24 hours of antibiotic treatment and presents with increase in temperature, decrease in blood pressure, rigors, and leukopenia (“the comet of fire and ice”); may occur during treatment of any of the spirochete diseases.

- **Prevention:** benzathine penicillin is given to contacts; no vaccine is available

- **Disease: The Stages of Syphilis**

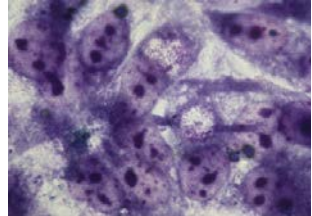
Stage	Clinical	Diagnosis
Primary (10d to 3mo after exposure)	Nontender chancre (“phallic sundial poking researcher in the butt, but painless as researcher is unaffected”); clean , indurated edge; contagious; heals spontaneously 3-6 weeks but progresses because painless is left untreated typically	Dark field or fluorescent microscopy of lesion; 50% of patients will be negative by nonspecific serology
Secondary (1 to 3 mo later)	Maculopapular (copper-colored) rash that is diffuse, and includes palms and soles (“astronaut wearing suit with red gloves and boots”); patchy alopecia; condylomata lata: flat wart like perianal and mucous membrane lesions (“astronaut pointing at weird planet with “a lata” bumps”); highly infectious	Serology is nonspecific and specific; both positive; spirochetes can be visualized within the condylomata lata via darkfield microscopy (“students looking through dark telescopes”)
Latent	None	Positive serology
Tertiary (30% of untreated, years later)	Gummas or syphilitic granulomas that are soft growths with firm necrotic centers (“bright cratered moon”), aortitis and aneurysm of ascending aorta with tree-barking appearance (“tree shaped like aorta with branches coming off the ascending portion”); destroys the vasa vasorum that supplies the aorta with blood (“targeting the roots of the tree”); CNS inflammation – damage to the posterior column of the spinal cord (“columns in the background of picture that are cracked and damaged”) and ocular defect of Argyll Robertson pupils which react to accommodation but has no reaction to light (“greet with Argyll sweater accommodating kid flashing light at him”)	Serology: specific tests; nonspecific may be negative
Congenital (babies of IV drug-users)	Still birth, keratitis, 8th nerve damage; most born asymptomatic or with rhinitis, which can lead to widespread desquamating maculopapular rash and tabes dorsalis. Can have Saber-shins or anterior bowing of the tibia (“Orion constellation with saber that ends by his shins”); saddle nose (“saddle on Pegasus constellation”); Hutchinson’s notched teeth and Mulberry molars with enamel outgrowths (“kids shivering with chattering teeth”); deafness (“kids also wearing earmuffs”)	Serology: should revert to negative within 3 mo of birth if uninfected





FAMILY: CHLAMYDIACEAE “The Pirates of Chlam Island”

- **Family Features:** obligate intracellular bacteria – cannot replicate outside host cell (“pirate ship is stuck on the island”); therefore cannot make its own ATP; not seen on gram stain (“white island”); cell wall lacks muramic acid (“banner on ship with no mermaids allowed symbol”); found in cells as metabolically active, replicating reticulate bodies (“pearls found inside clams”); infective form is inactive, extracellular elementary bodies (“pearls outside clams falling into the water”)
- **Diagnosis:** Cytoplasmic inclusions seen on Giemsa- (“treasure chest of gems”), iodine-, or fluorescent-anti-body-stained smear or scrapings; DNA probes in US (rRNA) and PCR; commonly diagnosed by NAAT – nucleic-acid amplification test (“Gnats flying around the treasure chest”); cannot be cultured on inert media; is cultured in tissue cultures or embryonated eggs (“piles of pearls”); serodiagnosis by DFA or ELISA



Chlamydia trachomatis

- **Reservoir:** human genital tracts and eyes; **Transmission:** sexual contact and at birth (“sexy mermaid with baby”); trachoma is transmitted by hand-to-eye (“Captain pirate representing trachoma with his hands shielding eyes”) and flies
- **Pathogenesis:** infection of nonciliated columnar or cuboidal epithelial cells of mucosal surfaces leads to granulomatous response and damage
- **Diseases:**
 - STDs in the US: for Serotypes D-K – this is the most common bacterial STD in the US, although overall herpes and HPV are more common.; characterized by watery discharge (“leak in the ship”) and causes nongonococcal urethritis, cervicitis, Pelvic Inflammatory Disease (“flag with skull symbol shaped as uterus and uterine tubes and ovaries”) and major portion of infertility; inclusion conjunctivitis (“mother mermaid covering baby’s eyes”) and pneumonia (“baby wearing clam shelled bra with algae”) in neonates/ infants that presents with staccato cough
 - Lymphogranuloma venereum: from serotypes L1-L3 – this STD is prevalent in Africa, Asia, and South America. Presents first with a painless ulcer at the site of contact then progresses to swollen lymph nodes leading to genital elephantiasis in late stage (“barnacles around the inguinal region of mermaid”); tertiary stage presents with ulcers, fistulas, and genital elephantiasis
 - Trachoma: from serotypes A, B, Ba, and C – is the leading cause of preventable infectious blindness (“captain pirate has two eye patches”). Follicular conjunctivitis leading to conjunctival scarring; in-turned eyelashes leading to corneal scarring and blindness
- **Treatment:** doxycycline (“captain steering wheel shaped as bicycle wheel”) or azithromycin, a macrolide (“crows at the top of the ship”)
- **Prevention:** Erythromycin is effective in infected mothers to prevent neonatal disease. Treat neonatal conjunctivitis with systemic erythromycin to prevent pneumonia.

Other *Chlamydophila* Species

Organism	<i>C. pneumoniae</i>	<i>C. psittaci</i>
Distinguishing characteristics	Potential association with atherosclerosis	No glycogen in inclusion bodies
Reservoir	Human respiratory Tract	Birds, parrots (“a parrot pooping on Mermaid”), Turkeys
Transmission	Respiratory Droplets	Dust of dried bird secretions and feces
Pathogenesis	Intracellular growth; infects smooth muscle, endothelial cells, or coronary artery and macrophages	Intracellular growth
Disease	Atypical “walking” pneumonia (“adult mermaid with clam shell bra and algae”); single lobe; bronchitis; scant sputum; prominent dry cough and hoarseness; sinusitis	Psittacosis (ornithosis aka Parrot Fever); atypical pneumonia with hepatitis; cough may be absent, when present, nonproductive at first, then scant mucopurulent; CNS and GI symptoms may be present
Diagnosis	Serology (complement fixation or microimmunofluorescence)	Serology (fourfold rise in antibody titer), complement fixation
Treatment	Macrolides and Tetracycline	Doxycycline
Prevention	None	Avoid birds

- **Note:** commonly coinfects with *N. gonorrhea* (“pirate wearing same hat as Mac Detective from Neisseria series”) – treat both empirically with ceftriaxone (“ship’s flag with 3 axes symbol”)



COXIELLA BURNETTI “Curly Q the Ram”

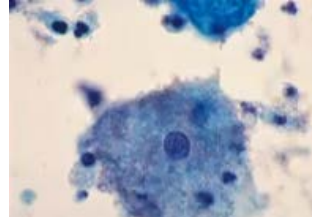
- **General Features:** gram- (“red barn setting”), **obligate intracellular organism** (“locked inside the barn”)
- **Reservoir:** spores survive in animal/ livestock hosts and feces (“walnut symbol for spores and poop on the ground”)
- **Transmission:** farmers or vets with a lot of animal-human contact; transmitted via aerosol transmission (“Ram kicking up a dust cloud”)
- **Disease:** Q Fever (“Ram has curly Q horns”); **presents without a rash** (“Ram is pristine white”), **causes pneumonia** (“farmer in the dust cloud coughing”), **headache** (“farmer hitting his head on the rafter”), **and fever** (“farmer sweating profusely”). **Most important symptom is hepatitis** (“cow with spots that resemble the liver”)
- **Treatment:** self-limiting, typically resolves in 2 weeks; may develop endocarditis in the immunocompromised or in those with previous heart valve problems
- **Prevention:** pasteurize the milk





GARDNERELLA VAGINALIS “The Fish Garden”

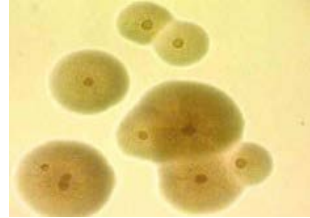
- **General Features:** Gram-variable rods – can be Gram+ or Gram- (“purple and red graffiti on the wall behind the market”); **facultative anaerobe**
- **Reservoir:** human vagina
- **Transmission:** endogenous – normal flora gets disturbed, increased pH, allowing for overgrowth
- **Pathogenesis:** polymicrobial infections; works synergistically with other normal flora organisms including *Lactobacillus*, *Mobiluncus*, *Bacteroides*, *Peptostreptococcus* – thought to flourish when the vaginal pH increases causing a reduction of vaginal *Lactobacillus* (“fish are disappearing from the market because of an overgrowth in Venus fly traps in the stall next door”); follows menses or antibiotic therapy
- **Disease:** bacterial vaginosis, produces a fishy vaginal odor (“scene set at a fish market”), with a thin, gray fluid discharge (“vulva-shaped Venus fly traps are covered in and leaking gray fluid”)
- **Diagnosis:** pH > 4.5 (“Sign ‘p4.5 and up’ for the Venus fly traps”); **Clue cells or epithelial cells covered with bacteria can be seen on vaginal saline smears** (“detective looking at the sheets where the fish went missing as clues; the blue fluid looks like the clue cells under a microscope”); **also Whiff Test: add KOH to sample and it produces the fishy amine odor** (“Detective dog whiffing the discharge on the ground”)
- **Treatment:** metronidazole (“metro train”) or clindamycin

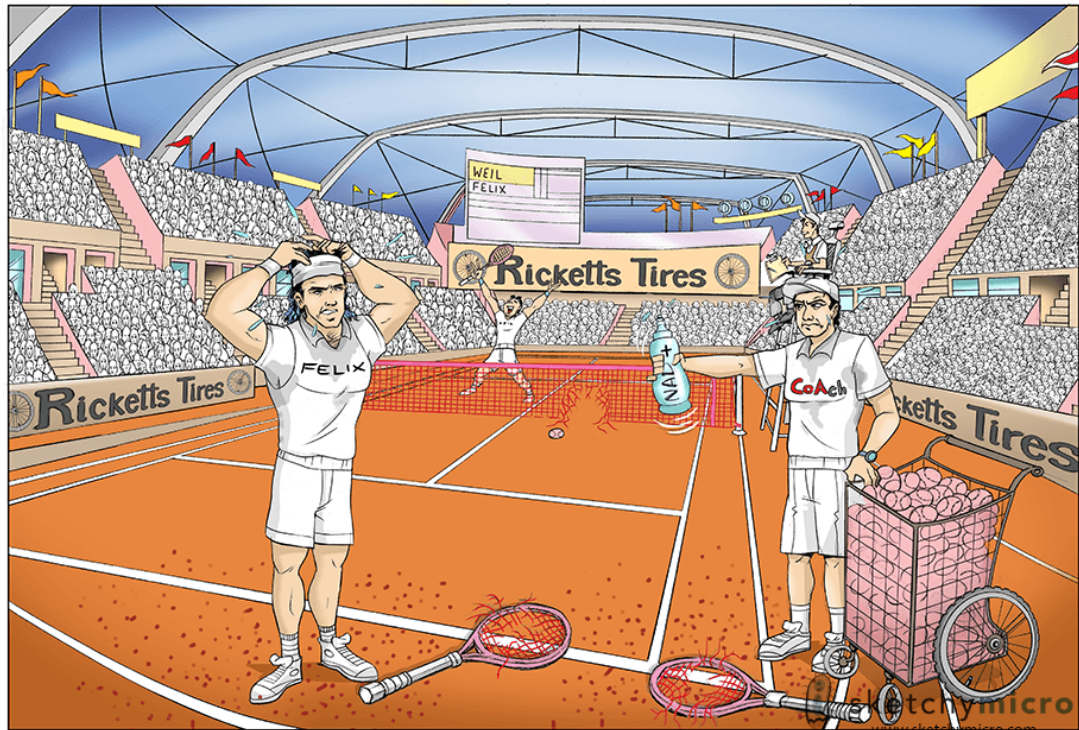




MYCOPLASMA PNEUMONIAE “Walking on Thin Ice”

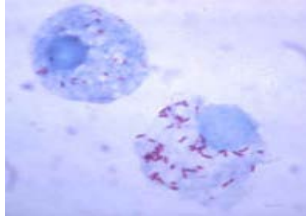
- **General Features:** smallest free-living (extracellular) bacteria, missing peptidoglycan cell wall (“no walls in this outdoor scene”), membrane contains sterols, but does not synthesize the cholesterol (“goal net has sterol rings emphasized”), requires cholesterol for in vitro culture, “fried-egg” colonies on *Mycoplasma* on Eaton’s media (“Don’t EAT ON Ice’ sign”)
- **Reservoir:** human respiratory tract
- **Transmission:** respiratory droplets, closer contacts, families, military recruits (“military camo jersey on the goalie”), medical school class, college dorms, young adults (“jersey’s number is <30”)
- **Pathogenesis:** Surface parasite, not invasive; attaches to respiratory epithelium via P1 protein; inhibits ciliary action; produces hydrogen peroxide, superoxide radicals, and cytolytic enzymes, which damage the respiratory epithelium, leading to necrosis and a bad, hacking cough (walking pneumonia); *M. pneumoniae* functions as superantigen, elicits production of IL-1, IL-6, and TNF- α
- **Disease:** Walking Pneumonia (“referee walking on ice”) presents with pharyngitis and dry hacking cough; may develop into an atypical pneumonia with persistent hack and little sputum produced; on X-Ray, patchy infiltrate can be seen (“patchy clouds in the sky”); is the most typical pneumonia (along with viruses) in young adults
- **Diagnosis:** primarily clinical diagnosis; PCR/ Nucleic acid probes; ELISA and Immunofluorescence sensitive and specific; Mulberry-shaped colonies on sterol-containing media in 10 days; Positive cold agglutinins – an autoantibody to red blood cells – test is nonspecific and positive in only 65% of cases (“hockey pucks are shaped as RBCs with IgM snowflakes clumping them together”)
- **Treatment:** macrolides (“crows checking out the scene”) – erythromycin, azithromycin, clarithromycin. Without cell wall, do not use cephalosporins or penicillin. No prevention methods.





GENUS: RICKETTSIA “Rickettsia Tennis”

- **Genus Features:** aerobic, gram- coccobacilli (“light pink, somewhat deflated tennis balls in basket to represent shape and gram-”), **too small to stain well with Gram stain** (“crowd wearing all white”), **obligate intracellular bacteria** (“inside a tennis stadium”), **unable to produce sufficient ATP, CoA** (“CoAch shirt”), and **NAD⁺** (“NAD⁺ written on water bottle”)
- **Diseases:** present with headache and fever (“Felix the tennis player is sweating and holding his head”), **vasculitis** (“bright red strings of the tennis racquet and net are broken”), and rash that may be associated with the vasculitis (“red clay pebbles next to the racquets”)
- **Diagnosis:** Weil-Felix test (“match is against Weil and Felix”) is a cross reaction of *Rickettsia* antigens with OX strains of *Proteus vulgaris*, and is no longer used, but may still be asked!
- **Treatment:** doxycycline (“sponsor of the match is Rickett’s Tire with bicycle tire symbol”)
- **Infections caused by Rickettsiae and Close Relatives:**

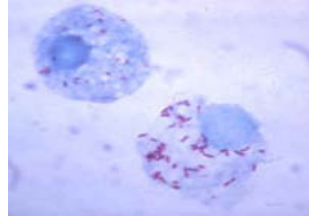


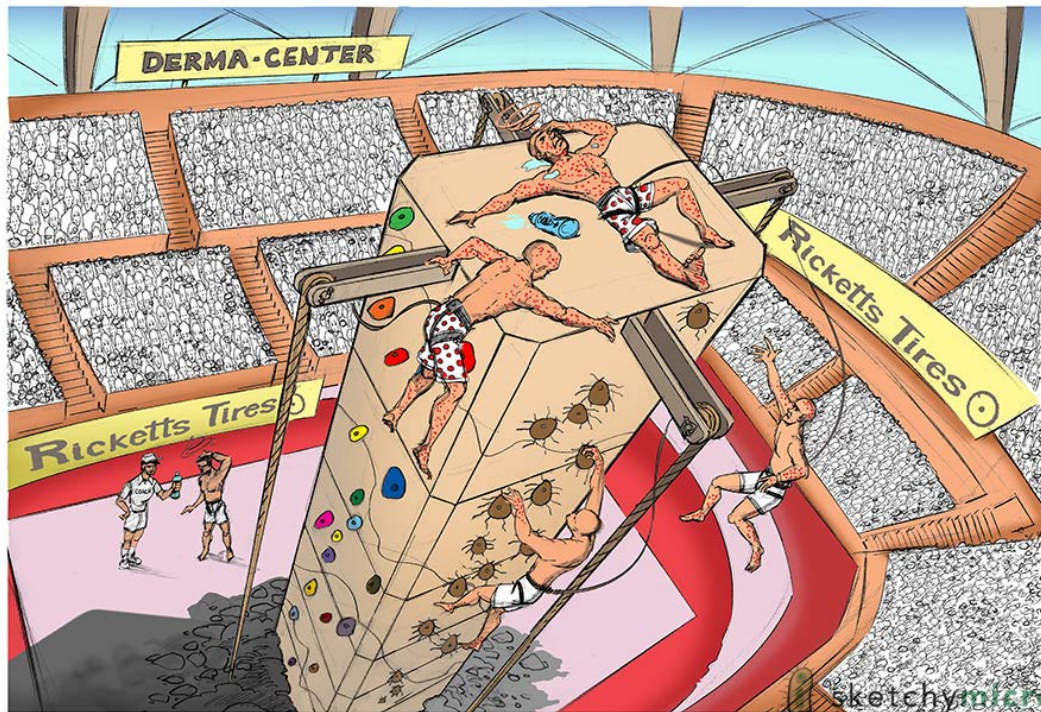
Group Disease	Bacterium	Arthropod Vector	Reservoir Host
Rocky Mountain Spotted Fever	<i>R. rickettsia</i>	Ticks	Ticks, dogs, rodents
Epidemic Typhus	<i>R. prowazekii</i>	Human Louse	Human
Endemic Typhus	<i>R. typhi</i>	Fleas	Rodents
Scrub Typhus	<i>Orientia tsutsugamushi</i>	Mites	Rodents
Ehrlichiosis	<i>E. echafeensis</i> <i>E. phagocytophila</i>	Tick	Small mammals



RICKETTSIA PROWAZEKII “Pro Boot Camp”

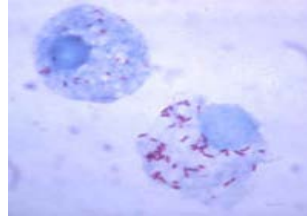
- **General Features:** too small to stain well with Gram stain (“crowd wearing all white”), **obligate intracellular bacteria** (“inside a tennis stadium”), **unable to produce sufficient ATP, CoA** (“CoAch shirt”), and **NAD⁺** (“NAD⁺ written on water bottle”)
- **Reservoir:** humans
- **Transmission:** lice/ human louse (“football players throwing around louse-shaped footballs...”); **typically affects military camp recruits and prisoner of war camps** (“coach is wearing a military hat”)
- **Disease: Epidemic Typhus** (“epidemic represented by ‘The Outbreak’ play”); **presents with rash that starts at the trunk and spreads outwards towards the extremities** (“coach is pointing at a play with players starting in the middle and spreading out”); **the rash usually spares the head, hands, and feet** (“uniforms of players are red except for the white helmet, gloves, and shoes”); **myalgias and arthalgias** (“player being tackled”); **pneumonia** (“player being tackled is coughing or winded”); and **encephalitis with dizziness and confusion** (“another player is holding his head”)
- **Treatment: doxycycline** (“sponsor of the match is Rickett’s Tire with bicycle tire symbol”)





RICKETTSIA RICKETTSII “Rickett’s Rock Climbing Competition”

- **General Features:** too small to stain well with Gram stain (“crowd wearing all white”), **obligate intracellular bacteria** (“inside a tennis stadium”), **unable to produce sufficient ATP, CoA** (“CoAch shirt”), and **NAD⁺** (“NAD⁺ written on water bottle”)
- **Reservoir:** small wild rodents and larger wild and domestic animals (dogs)
- **Transmission:** hard *Dermacentor* ticks (“DERMA-CENTER arena and tick rock-holds for the climbers”); also reservoir hosts because of trans-ovarian transmission
- **Pathogenesis:** invade endothelial cells lining capillaries, causing vasculitis in many organs including brain, liver, skin, lungs, kidney, and gastrointestinal tract
- **Disease:** Rocky Mountain Spotted Fever (RMSF), which is a medical emergency! It’s prevalent on the East Coast (OK, TN, NC, SC) – first begins with a 2-14 day incubation (“climber at the bottom is not covered in any rashes”); the maculopapular turned petechial rash starts (by day 6 of illness) on the ankles and wrists (“rock climbers closer to bottom with rash on ankles and wrists”) and then spreads to the trunk, palms, soles, and face – a centripetal rash (“the climbers at the top have a full-body rash”); ankle and wrist swelling also occur; headache, fever, malaise, myalgia, toxicity, vomiting, and confusion at its worst (“top climber is holding his head, sweating, and in pain”); diagnosis may be confused by GI symptoms, periorbital swelling, stiff neck, conjunctivitis, and arthralgias
- **Diagnosis:** clinical symptoms and tick bite; serological IFA test is most widely used; fourfold increase in titer is diagnostic; Weil-Felix test is no longer used
- **Treatment:** doxycycline (“sponsor of the match is Rickett’s Tire with bicycle tire symbol”)
- **Prevention:** tick protection and prompt removal; doxycycline effective in exposed persons



virus



PICORNOVIRIDAE “The Peak-orna Animal Nursery”

Overview for Picornavirus (“all of the animals have their pico/small animal counterpart”)

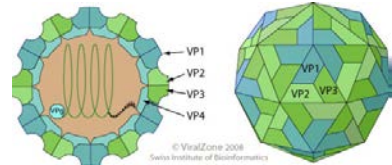
➤ **Family Characteristics:**

- **Positive sense ssRNA virus** (“during daytime with warm, bright colors”)
- **Naked virus** (“naked Statue of David”) resistant to alcohol and detergents
- **Icosahedral**
- **Replicates in cytoplasm**
- **Transmission: fecal-oral route** (“piles of poop all over”) except for Rhinovirus which is respiratory
- **Summer/fall peak incidence**
- **Positive sense RNA uses host RNA polymerase for translation and doesn’t need to carry RNA-dependent RNA polymerase** (“coin stamp machine-all of the machinery needed to process the coin exists within the machine”)
- **Creates large polyprotein product that needs to be cleaved into smaller subunits** (“roll of tickets being broken up”)

➤ **Viruses of Medical Importance** (covered in more detail in subsequent cards):

- **Hepatitis A** (“exhibit A is Hep A hippo”): **hepatosplenomegaly** (“mud spots on hippo shaped as liver”)
- **Enteroviruses** (“Exhibit B= birds= enteroviruses”) **#1 cause of aseptic meningitis** (“the aviary is shaped like a head and sign says 100% aseptic zone”) **with children most affected by meningitis** (“kid wearing meningitis space helmet”); **CSF findings of viral meningitis: normal glucose** (“no sugar added sign”), **aseptic** (“shows no organisms sign”), **elevated protein** (“good source of protein sign”)
 - **Poliovirus** (“polio flamingo”)
 - **Coxsackie A and B** (“cocksackie cockatoos”)
 - **Echovirus** (“mocking birds echo”): fever and rash of unknown origin and aseptic meningitis
- **Rhinovirus** (“Exhibit C= common cold= rhinovirus) **causes upper respiratory infection** (“mud on the rhinos nose”)

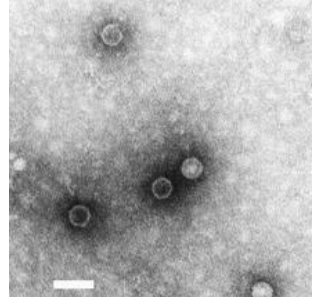
➤ **Treatment:** most have no specific treatment, polio and HAV have vaccines; **Prevention:** hand washing

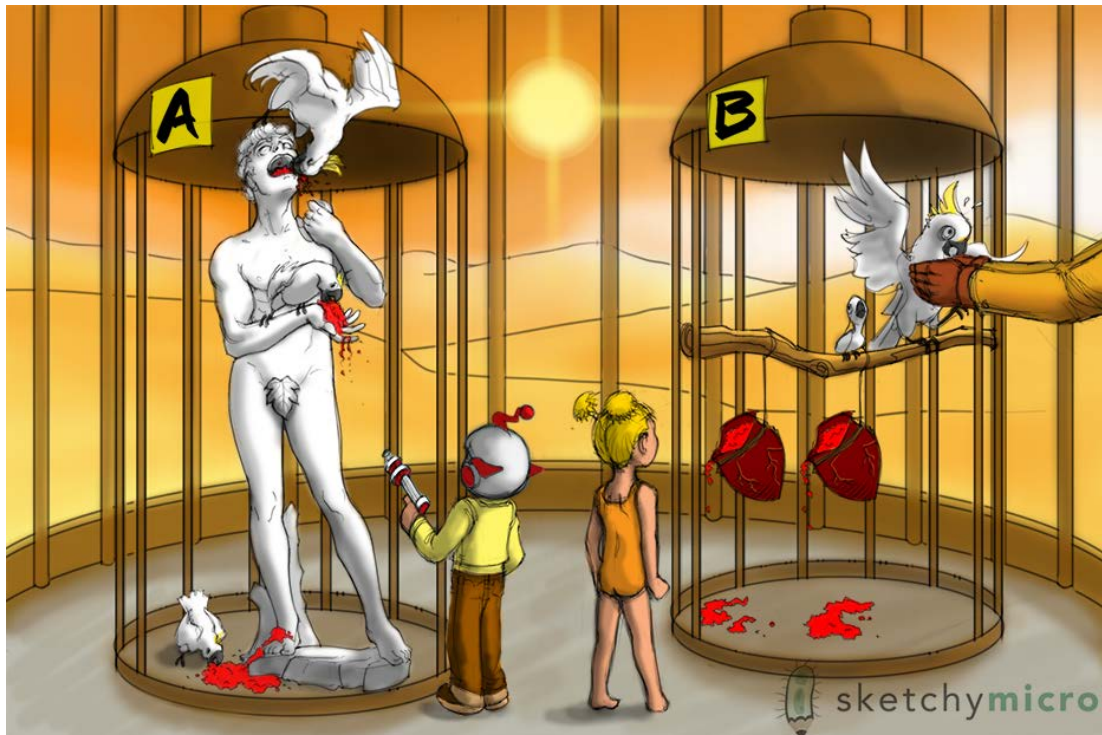




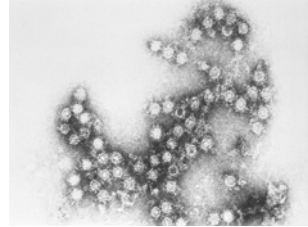
POLIOVIRUS “The Flamingo Breeding Pool” an **ENTEROVIRUS** (“scene in giant aviary”) in the **PICORNAVIRUS** Family (“flamingo has a pico/baby counterpart”)

- **General Features:** **positive sense ssRNA virus** (“scene in daytime with warm colors”), **naked virus** (“statue of David”) **fecal-oral transmission, acid stable** (“flamingo standing on rock stably in acid pool”)
- **Replication:** **replicates in lymphoid tissue such as tonsils and Peyer’s patches** (“eggs represent replication in lymphoid tissue in submucosa of gut with orange points for villi”) **specifically Peyer’s patches which takes 2-3 weeks** (“Peyer’s Flamingo sign-breeding season 2-3 weeks”)
- **Pathogenesis:** **spreads from lymphoid tissue to anterior horn of spinal cord** (“bird with large anterior horn”) and **causes flaccid asymmetric paralysis with no sensory loss** (“one leg of the flamingo bent up”), **myalgias, and respiratory insufficiency from paralysis of diaphragm** (“flamingo gasping for air”)
- **Disease:** **viral aseptic meningitis** (“kid with meningitis helmet”); **paralytic polio**
- **Diagnosis:** **serology (virus absent from CSF)**
- **Treatment:** **supportive**
- **Prevention:** **2 vaccines**
 - **Salk vaccine= inactivated/killed vaccine given through injection, which bypasses GI tract and only forms IgG antibodies** (“emo teen sulking with skull and crossbone-shaped syringes for killed vaccine”)
 - **Sabin vaccine= live attenuated vaccine given orally and creates both IgG AND IgA response** (“Sabin/Savin a life donation box with the A in red for IgA’) **Note- this vaccine is no longer used in the US because of the potential to shed in feces and infect others**





COXSACKIE A and B “Coxsackie Cockatoos” an ENTEROVIRUS (“scene in giant aviary”) in the PICORNOVIRUS Family (“cockatoo has a pico/baby counterpart”)



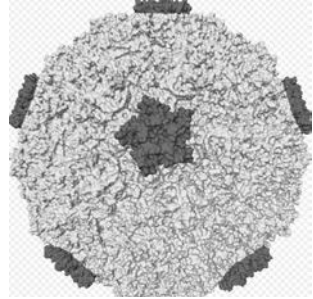
- **General Features:** **positive sense ssRNA virus** (“scene in daytime with warm colors”), **naked virus** (“statue of David”), **infections most common in summertime** (“girl in bathing suit”)
- **Transmission:** fecal-oral
- **Coxsackie A:** (“cage A on the left”)
 - **Diseases:** **Hand, foot and mouth disease (A16)** (“red bird seed with birds pecking at statues hands, feet, and mouth”) – **red vesicular rash** (“red bird seeds”), **aseptic meningitis** (“meningitis helmet”), **herpangina, common cold, lymphoglandular pharyngitis**
 - **Diagnosis:** virus isolation from throat, stool, or CSF
 - **Treatment:** supportive
 - **Prevention:** hand washing
- **Coxsackie B:** (“cage B on the right”)
 - **Diseases:** **dilated cardiomyopathy** (“loose and floppy bags of birdseed shaped like hearts”), **Devil’s grip/Borhnm’s Disease/Pleurodynia-extreme sharp pain in lower chest that is often unilateral** (“zookeeper reaching in and grabbing cockatoo by chest”), **severe systemic disease of newborns**
 - **Diagnosis:** virus isolation from throat, stool, or CSF
 - **Treatment:** supportive
 - **Prevention:** hand washing



RHINOVIRUS “Rhino Petting Zoo” in the **PICORNAVIRUS** family

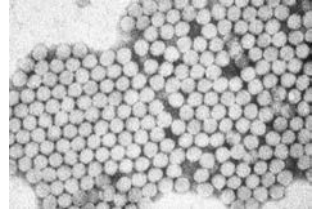
(“pico/baby rhino counterpart”)

- **General features:** **positive sense ssRNA virus** (“scene in daytime with warm colors”), **naked virus** (“statue of David”)
- **Transmission:** **RESPIRATORY** (all other picornaviruses are fecal-oral) (“rhino in front is sneezing for respiratory”) **because it is acid-labile and cannot go through GI tract** (“rhino being fed a lemon”). **Also spread by fomites** (“sign to wash hands”)
- **Pathogenesis:**
 - **Attaches to ICAM-1 to enter host cells** (“camera strap wrapped around rhinos horn and statue has camera”)
 - **Grows best at 33°C** (“rhinos lying in shade with 33 sign”)
 - **Has over 100 serotypes** (“canopy striped with many colors”) **makes it very difficult to make a vaccine**
- **Disease:** **#1 cause of common cold**; it’s cooler in the **upper respiratory tract** where air is constantly moving in and out acting as **air conditioner** – thus **primarily affects URI** (“baby rhino with mud on nose, chin and neck, but not below”). **Peak incidence in summer/fall**
- **Diagnosis:** **clinical**
- **Treatment:** **no specific**
- **Prevention:** **hand washing**





HEPATITIS A “Hungry Hungry Hep A Hippo” in the PICORNAVIRUS family (“pico/baby hippo counterpart”)



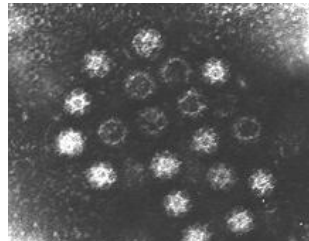
- **General features:** **positive sense ssRNA virus** (“scene in daytime with warm colors”), **naked virus** (“statue of David”) **acid-stabile** (“hippos on rock above acid pond”)
- **Transmission:** **fecal-oral** (“piles of poop”) **can be shed in feces and then contaminate water supplies**
 - **Contaminated water is a common source in DEVELOPING countries** (“man getting water from contaminated water”). **Hep A is inactivated in developed countries by chlorination, bleach, UV radiation, or boiling** (“purified water sign and machine”)
 - **Contaminated shell fish are a common source in DEVELOPED countries like the USA** (“shellfish being pulled right out of contaminated poop pond to be sold at booth with ‘USA Shellfish’ sign”)
 - **Commonly seen in travelers to endemic areas, esp southern hemisphere** (“backpack for traveling”)
- **Pathogenesis:** **virus targets hepatocytes; liver function is impaired** (“liver shaped mud spots on hippo”)
- **Disease:** **Infectious hepatitis**
- **Symptoms:**
 - **Jaundice, esp in adults** (“yellow jumpsuit”)
 - **Anicteric hepatitis in young children and infants** (“child doesn’t have jaundice jumpsuit on”)
 - **Smokers who develop Hep A develop an aversion to smoking** (“man extinguishing cigarette”)
 - **One month duration of symptoms** (“shellfish booth sign-one month only”)
 - **Self-limiting** (“shellfish booth sign-limit one per customer”)
 - **No carrier/chronic state** (“shellfish booth sign-no carrying out of food”)
- **Diagnosis:** **IgM to HAV serology; Treatment: no specific**
- **Prevention:** **inactivated vaccine** (“tranquilizer gun on women pulling shellfish out of the pond”) **and hyperimmune serum**



CALICIVIRIDAE “cali-sea shore” and “khaleesi’s 3 Dragons from GOT”

Family characteristics:

- “Naked statue of David” = **a naked virus, icosahedral shape**
- “orange tones, sunny day with plus-sign sun” = **positive-sense ssRNA**
 - **ssRNA replicates in cytoplasm**



Viruses of Medical Importance:

- **Norwalk virus (Norovirus)** = “Narwhal jumping out of the ocean”
 - “long string of tickets broken up” = **it is a virus that produces one long polyprotein that is cleaved by viral proteases to become active**

➤ **Reservoir** – human gastrointestinal tract

➤ **Transmission** – “shellfish and buffet” = **fecal-oral route, contaminated by food and water**

➤ **Disease** – acute gastroenteritis; is leading cause of non-bacterial

- **Causes watery (no blood or pus), noninflammatory diarrhea, nausea and vomiting** = “propeller in brown muddy waters”
- **Outbreaks of viral gastroenteritis in “cruise ships” are attributed to Norovirus** (“setting on cruise ship”)
- “Many children on the poop deck” = **outbreaks are also common in day care centers and schools**

➤ **Diagnosis** – RIA, ELISA

➤ **Treatment** – it is self-limiting; there is no antiviral tx

➤ **Prevention** – handwashing allows for mechanical removal of the virus



FLAVIVIRUS “Flavor Paked Flavi!”

- **General features:** **positive sense ssRNA virus** (“scene takes place in day with warm RNA colors”), **enveloped** (“togas/robes”), **non-segmented** (“straw in juice boxes are straight not bendy to remember only one segment”), **arthropod-borne (arboviruses)**

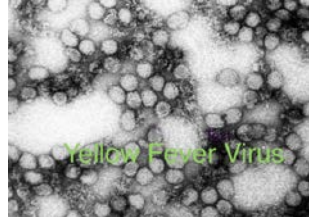
➤ **Diseases:**

- **Hepatitis C** (“Hep C flavorful fruit punch stand along with Hep C Hippo with C shaped ear tag and liver mud spots for hepatitis”): covered in separate card
- **Dengue Fever** (“Dinghy”)
 - **Vector:** **Aedes Egyptei Mosquito** (“guy in dinghy swatting off mosquitos”) **Hosts:** **humans (monkeys)**
 - **Also called Break-Bone fever because it infects bone marrow** (“oar made out of bone and broken in two pieces”)
 - **Complications:** **thrombocytopenia which increases risk of bleeding and can lead to hemorrhagic fever** (“RBC-lifeboats floating around dinghy”), **renal failure** (“dinghy is kidney shaped”)
- **Yellow Fever** (“yellow water buffalo”)
 - **Vector:** **Aedes Mosquito** (“mosquitos around buffalo”) **Hosts:** **humans (monkeys)**
 - **Symptoms:** **jaundice** (“yellow with liver shaped mud spot”), **backache** (“exaggerated hump on back”), and **bloody diarrhea and vomiting** (“red stool under man trying to get on buffalo”)
 - **Vaccine:** **live attenuated vaccine for travelers** (“buffalo being injected by syringe”) **Note: this is the only flavivirus with a vaccine**
- **West Nile Virus** (“birds in the river”)
 - **Vector:** **CULEX Mosquito (not Aedes)** (“mosquitos around the birds”); **Host:** **birds (killed by virus)**
 - **Complications:** **encephalitis** (“red turbans on birds”), **meningitis** (“bird with neck brace”), **flaccid paralysis** (“bird with floppy neck”), **seizures** (“bird flapping wings”), and **coma** (“bird passed out in river”)
- **St. Louis Encephalitis Virus (SLE):**
 - **Vector:** **Culex mosquito, Hosts:** **birds**

- **Diagnosis:** serology, hemagglutination inhibition, ELISA, latex particle agglutination

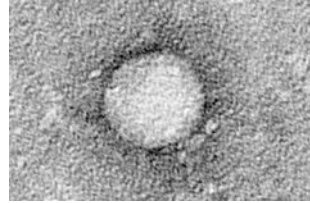
- **Treatment:** supportive

- **Prevention:** vector control





HEPATITIS C “The Hep Sea” member of the FLAVIVIRUS family (“explorers are sipping FLAVI-ful Hep C punch”)

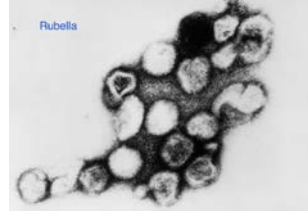


- **General features:** **positive sense ssRNA virus** (“scene takes place in day with warm RNA colors”), **enveloped** (“robe”) – **with antigenic variability of envelope proteins** (“multi-colored tent”), **non-segmented** (“straw in juice boxes are straight not bendy to remember only one segment”), **arthropod-borne (arboviruses)**
- **Transmission:** **blood transfusions** (“hippo in bloody water”), **needle sharing or sticks** (“needle through hippos ear”); **sexual contact**
- **Pathogenesis:** **antigenic variability** (“multicolored tent”)
 - **Virion encoded RNA polymerase lacks proofreading exonuclease activity** (“hippopotamus sign is misspelled”) in **3’-5’ direction** (“no viewing from 3-5”) **making it prone to mutations: the virus mutates so quickly that there is usually no protection against recurring infections after a person has had Hep C**
- **Disease presentation:** **fever, malaise, headache, anorexia, vomiting, dark urine, jaundice** (“yellow hippo with liver shaped mud spot”)
- **Acute Infection:** **ALT will rise and fall by 6 months** (“ALT buoy on wave rising and falling”)
- **60-80% of Hep C infections become chronic** (“chronically infected sign” also remember C for Chronic)
 - **Primary cause of hepatocellular carcinoma** (“crab symbol for cancer on the sand”)
 - **Cirrhosis** (“liver looks like dead washed up coral”)
 - **Viral RNA persists in serum after 6 months; liver biopsy will show lymphocytes in the portal tract**
- **Associated with cryoglobulins-** **serum proteins containing immunoglobulins (mostly IgM) that precipitated out in cooler temps** (“5 sided crystals that look like IgM crystalized out of the cold water”)
- **Treatment:** **ribavirin** (“ribs”), **Interferon α** (“walky-talky has interference, with α shaped antennae”), and **protease inhibitors** (“meat cleaver that is stuck/inhibited by a tree”)



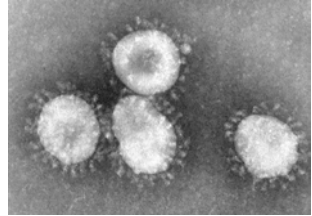
TOGAVIRUS “Toga-toga-togavirus”

- **General Features:** positive sense ssRNA (daylight with warm RNA colors”), **enveloped** (“togas”), **replicates in cytoplasm**, **long polyprotein precursor cleaved by proteases** (“tickets being broken off of ticket roll”)
- **Arboviruses** (“man riding horse hitting head on arbor”):
 - **Western, Eastern, and Venezuelan Equine Encephalitis** (“compass on horse for names based on geographical location, horse for equine, and red turban for encephalitis”)
 - **Vector= arthropods – mainly mosquitos** (“mosquitos swarming man on horse”)
 - **Hosts: birds and horses**
 - **Diagnosis: Cytopathology, immunofluorescence, RT-PCR, serology**
 - **Prevention: killed vaccine for EEE and WEE; no treatment, but protect against vector**
- **Rubella/German Measles** (“Rubies everywhere on throne and crown”)
 - **Transmitted via respiratory droplets** (“water coming off plant fans”); **Hosts = humans**
 - **Common childhood exanthema** (“emperor is a child”); **rash spreads faster than rash of Measles and lasts 3 days**
 - **Symptoms: postauricular and occipital lymphadenopathy** (“rubies running behind ear and down back of neck”)
 - **Maculopapular rash that begins on face and spreads downward** (“rubies falling down off crown”)
 - **One of the TORCHes infections for Toxoplasma gondii, Rubella, CMV, HIV, HSV, and Syphilis** (“torches on wall”) **can cross placenta and cause congenital rubella** (“babies as statues on the pillars”):
 - **Symptoms: mental retardation, microcephaly, deafness** (“babies covering ears”), **blindness, cataracts** (“babbies have creepy eyes”), **jaundice** (“babies are yellow”), **patent ductus arteriosus** (“wall named aquaductus arteriosus with open sign”), **pulmonic stenosis, purpuric blueberry muffin rash** (“arches shaped like muffins with blue gems”), **radiolucent bone lesions**
 - **Classic triad: congenital cataracts, sensorineural deafness, patent ductus arteriosus**
 - **Adult Rubella: arthralgia and arthritis** (“kneeling people with knee pain”)
 - **Prevention: MMR live attenuated vaccine** (“3 puppets for measles, mumps and rubella playing a live show”) **contraindicated in pregnant woman** (“pregnant puppet avoiding getting poked”) **and HIV patients should receive vaccine only with CD4 count >200** (“200 tickets sign”); **Rubella more prevalent with unvaccinated and immigrants**





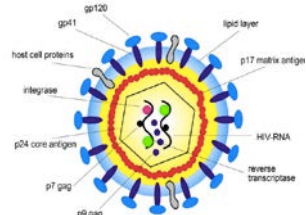
CORONAVIRUS “Kingdom of SARS” with “King wearing crown”



- **General Features:** positive sense ssRNA virus (“daytime with warm RNA colors”), replicates in cytoplasm, enveloped (“robe”), helical shaped (“long spiraling road and spiraling trees”), hemagglutinin molecules make up peplomers on virus surface, which give shape like sun with corona
- **Diseases:**
 - **Common cold** (“king sneezing and blowing nose”)- 2nd most common cause, winter/spring peak incidence
 - **SARS and Middle East Respiratory Syndrome (MERS)**
 - **Reservoir:** birds and small mammals
 - **Transmission:** respiratory droplets (original case thought to have jumped from animal to human)
 - **Disease:** Severe acute respiratory syndrome (“red and inflamed respiratory tract with bronchioles on king’s outfit”) – an acute bronchitis that leads to ARDS
 - Fever, flu-like illness, dry cough, dyspnea, and progressive hypoxia
 - Chest x-ray may show patchy distribution of focal interstitial infiltrates
 - **Diagnosis:** clinical presentation and prior history of travel to an endemic area. Detection of antibodies to SARS or PCR; negative finding with absence of antibodies over 28 days
 - **Treatment:** supportive. Ribavirin and interferon are promising



RETROVIRUS: HIV “One cane to rule them all”

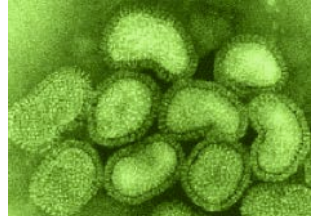


- **General features:** **diploid** (“wizard cap with 2 orange dragons- 2 copies of the ssRNA **positive sense ssRNA** (“daytime with warm RNA colors”), **contains RNA-dependent RNA polymerase (reverse transcriptase), integrase, and protease and is enveloped** (“robed”)
- **Transmission:** **sexual, blood or vertical TORCHES infection** (“torches in hallway”)
- **Progression** (“follow spell for path of progression”): **virus initially targets macrophages** (“wizard breaking out of jail”) and **helper T cells** (“squire, because he helps”)
 - **Primary infection or prodrome - flu-like symptoms, lymphadenopathy and fever** (“squire, sweaty with fever, kneeling in pain and grabbing neck”). **CD4+ T cells are infected** (“dressed in white for WBC and 4 on belt”); **gains entry via CCR5 receptor in early stages** (“banner on first squire with CCRV symbol”)
 - **Virus enters latent period for up to 10 years while it is replicating in lymph nodes** (“sleeping squire”), then **steep decline in CD4+ T cells. AIDS diagnosed when CD4 <200** (“steep drop off cliff with many squires falling down, sign says 200 ft drop”); **gains entry via CXCR4 receptor in late stages** (“squires of later stages falling off cliff with banners with CXCR4 symbols”)
- **HIV associated diseases:** **can cause Diffuse Large B Cell Lymphoma** (“large crab, sign for cancer, attacking archers shooting antibody like arrows/ archers=B cells”)
- **Diagnosis:** **screening test for HIV= ELISA to look for antibodies** (“she-elf holding ELISA shield, arrows sticking out for antibodies”) **confirmatory test= Western blot** (“tapestry that looks like western blot behind ELISA elf so you know it is done second”) **ELISA is false-negative if tested too early**
- **Treatment:**
 - **HAART- 2 nucleoside analogs and 1 protease inhibitor ; Protease inhibitors** (“squire’s sword is stuck in the stone so can’t cut proteins”)
 - **NRTIs-nucleotide reverse transcriptase inhibitors best; during pregnancy** (“pregnant she-elf on a reversum transcriptum book because it inhibits reverse transcriptase with oddly shaped foul to remember nucleotide shape. Has **Z for Ziduvudine** which was first approved for use”)
 - **NNRTIs- nonnucleotide reverse transcriptase inhibitors** (“he-elf on book holding mase without a chain because it doesn’t get incorporated into the chain but has same result of inhibiting reverse transcriptase, so also standing on reversum transcriptum book”)
 - **CCR5 Inhibitor, Maraviro** (“Mare-horse rearing up, about to crush squire with CCR5 banner”): **prevents fusion of virus with host cell**

Genes	Product	Function
Gag	p24 (“sundial brim for 24 hours”)	Capsid protein
	p17	Matrix protein
	p7	Core nucleocapsid proteins
Pol	Reverse transcriptase (“spell book to create DNA from RNA”)	Produces dsDNA provirus (very error-prone)
	Integrase	Viral DNA integration into host cell
	Protease	Cleaves viral polyprotein
Env	gp120 (“marijuana pipes for 420- 120 is outer protein so bowl part facing out”)	Surface protein-binds CD4 and coreceptors CCR5 (macrophages) and CXCR4 (T cells) (“CCR5 sign on early squire and CXCR4 on late stage squire”)
	gp41 (“pipe in mouth for inner”)	Transmembrane protein for viral fusion to host cell



ORTHOMYXOVIRUS “Night shift at the orthodontist’s”



- **General features:** negative sense ssRNA virus (nighttime scene with warm RNA colors and moon with negative-sign cloud”) **enveloped** (“white coat”), **replicates in NUCLEUS** (this is the only RNA virus that doesn’t replicate in the cytoplasm) (“baby octopus swimming around in nucleus like helmet”)
 - **Note:** all negative sense RNA viruses need to bring their own RNA polymerase with them because they need to be transcribed into a positive sense
- **8 segments** (“8 tentacles of octopus”), which allows for **antigenic variation** (“multicolored curtains”):
 - **Antigenic drift:** point mutations in the genome leading to changes in the **hemagglutinin (HA)** and **neuraminidase (NA)** molecules (“DoKtor DRIFT sign-one letter changed for point mutation”). Causes epidemics/seasonal flu. **Influenza A and B**
 - **Antigenic shift:** rare genetic assortment. **Coinfection of cells with two different strains of influenza- produces a new agent that the population has no immunity to** (“night shift with H falling to bottom to represent reassortment/potential new species”) **causes pandemics. Influenza A only**
- **Pathogenesis**
 - **Hemagglutinin (HA)** (“rocks the octopus is sitting on look like RBCs stuck together in ‘HEME aquarium’”): **glycoprotein on envelope, which binds to sialic acid and causes RBCs to clump together in test tubes** (“plants/rocks look like sialic acid residues bound by HA”). **There are different HA antigens but H1, H2, and H3 are seen in influenza that infects humans** (“octopus has multicolored suckers to remember variety”) **and determines cell tropism/which cells the virus can bind to. Anti-HA antibodies are what protect you from infection with the same strain in the future.**
 - **After virus binds to sialic acid on membrane, the virus is endocytosed but in order for viral encoding to occur the pH needs to be just right. This is accomplished by M2 protein** (“shell ridges in tank look like 2 M’s”). **Amantidine and rimantidine inhibit M2 which prevents viral replication** (no uncoating) (“manta ray ready to dine on octopus – manta-dine”) – **only works on influenza A because B lacks M2 proteins**
 - **After the viruses replicate in the nucleus, they are bound to the host cell through same sialic acid residues that HA was initially bound to. Neuroaminidase (NA) cleaves sialic acid to release virions from host cell** (“scalpel to cleave sialic acid, missing from nurse assistant tray for NA”)
 - **Tamaflu is a trade name for oseltamavir which is an NA inhibitor and prevents release of virions** (“nurse assistant’s name is Tammy V for tamaflu”). **Needs to be given within 72 hours period or not effective because virions have been released already**
- **Disease:** Influenza A, B, C. **spread via respiratory droplets** (“drops coming off aquarium”). **Headache, malaise, fever, chills, anorexia, bronchiolitis, etc.**
- **Complication:** **pneumonia** (“lungs on kid’s bib”) **could be caused by staph aureus** (“golden staff inspecting child’s mouth”). **Associated with Guillain-Barre** (ascending paralysis, CSF has high protein with low WBCs – **albuminocytologic dissociation**) (“kid grabbing leg of stuffed bear”)
- **Vaccines:** **live attenuated nasal spray** (“bubbles going up through nose-shaped structure in tank”) **and killed injection** (“syringe impaling skeleton”). **Trivalent vaccine = 2 A strains + 1 B strain. Quadrivalent vaccine = 2 A’s + 2 B’s**
- **Treatment:** **aspirin** (“big aspirin bottle”) **is contraindicated in children with viral illnesses: Reye syndrome- fatty liver, liver failure** (“cow with liver spot on aspirin bottle”), **encephalitis** (“man with red turban on aspirin bottle”), **fever** (“sun- also rays for Reye’s”), **rash and vomiting**



PARAMYXOVIRUS “Paranormal mixer”

- **Family Characteristics:** enveloped (“ghosts covered in sheets holding enveloped invitations”), **helical nucleocapsid, negative-sense ssRNA** (“orange, warm tones with moon and negative-sign cloud”), **replicates in the cytoplasm**

Measles Virus

- **Distinguishing characteristics:** **single serotype**; has **Hemagglutinin glycoprotein** (“lady weasel reaching for bowl of clumped red berries and tentacles – a symbol from Orthomyxovirus video”) and **fusion protein** (“little weasel holding sticky substance”)
- **Reservoir:** human respiratory tract; **Transmission:** respiratory droplets (“droplets from sprinkles”)
- **Pathogenesis:** Ability to cause cell: cell fusion leads to giant cell formation; virus can escape immune detection
- **Disease:** Measles (“family of weasels”) aka **Rubeola** (“lady weasel wearing Ruby-Hola Spanish dress”); **presents with 4C’s** (“4 C buttons on papa weasel”): **Cough, coryza** – runny nose, conjunctivitis, and **Koplik Spots** (“father weasel coughing with drippy nose and red eyes”); **Koplik spots are small bluish-white spots on a red background found in the buccal mucosa inside the cheek near the 2nd molars** (“papa weasel eating blue-white candies from the pink bowl”); **fever** (“papa weasel sweating”); **after a day when the koplik spots form, a maculopapular rash from the ears down forms and eventually becomes a confluent rash** (“mama weasel wearing a headband of rubies falling off and dress represents confluent rash”); **later complications include giant cell pneumonia of Warthin-Finkeldey cells** (“papa weasel with large untied bowtie in shape of lungs”) and **Subacute sclerosing panencephalitis (SSPE)**, an inflammation and sclerosing of the brain, a chronic CNS degeneration from defective measles virus persisting in the brain (“child weasel wearing encephalitis turban watching Tales of SSPence puppet show”)
- **Diagnosis:** Serology; **Treatment:** supportive, Ribavirin (experimental); **Prevention:** Vitamin A reduces measles morbidity and mortality (“papa weasel wearing ‘A’ party hat”) – live, attenuated MMR vaccine available (“live puppet show with 3 puppets, one holding syringe, and another pregnant for contraindication”)

Mumps Virus

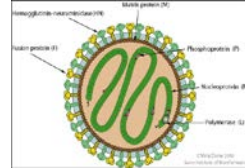
- **Distinguishing characteristics:** has **hemagglutinin glycoprotein** (“mummy holding tray of clumped berries and tentacles”) and **fusion protein** (“child mummy holding sticky substance”) and **Neuroaminidase** (“scalpel as it cleaves virus for release”); **single serotype**
- **Reservoir and Transmission:** same as Measles
- **Pathogenesis:** lytic infection of epithelial cells of upper respiratory tract and parotid glands leads to spreading throughout body
- **Disease:** Mumps (“represented by mummy family”) – **asymptomatic to bilateral parotitis** (“swollen mummy cheeks”) with **fever, headache, and malaise**; complications include **pancreatitis, orchitis** (“mummy holding single orchid by genital region”) that leads to **sterility in males**, and **meningoencephalitis** (“mummy wearing neck brace”)
- **Diagnosis:** Clinical; serology; ELISA, ISA, hemagglutination inhibition; **Treatment:** supportive; **Prevention:** live, attenuated MMR vaccine

Respiratory Syncytial Virus (RSV)

- **Characteristic:** contains **fusion protein** (“baby ghosts playing with sticky substance”); **Transmission:** Respiratory
- **Pathogenesis:** Attaches to **G protein** to infect **respiratory epithelial cells** (“baby ghost holding ‘G’ worm”)
- **Disease:** #1 cause of atypical pneumonia (low fever, tachypnea, tachycardia, expiratory wheeze), and **bronchitis and necrosis of bronchioles in infants** (“baby ghosts with bronchiole trees”); in **Adults** – just colds
- **Diagnosis:** IFA, ELISA, RT-PCR; **Treatment:** Ribavirin (“rib cage around baby ghosts”); **Palivizumab** (“pale baby ghost playing with IgG rattle”) **blocks fusion protein**

Parainfluenza Virus

- **Distinguishing characteristics:** has all 3 virulence factors (“3 wolves”); **Transmission:** Respiratory
- **Disease:** Croup aka **laryngotracheobronchitis** in infants – **characteristic seal bark cough** (“seal with the wolves barking at the moon”) and **inspiratory stridor** (“howling gust of wind blowing church door open”); **presents with cold, bronchitis, and pneumonia in infants**. In older children and adults, presents with **subglottal swelling** seen on X-ray as a “**steeple sign**” (“Church with steeple”), hoarseness, and barking cough.
- **Diagnosis:** RT-PCR; **Treatment:** Supportive/ None





RHABDOVIRUS “Rabid Wrecking Yard”

- **General features:** negative sense ssRNA virus (“nighttime moon with warm RNA colors”), bullet shaped (“bullets on dog collar”) with a helical nucleocapsid (“dog has helical shaped tail”), enveloped (“doggy hoodie”)
- **Reservoir:** bats, foxes, skunks, and raccoons in US (“animals in scene”); Worldwide dogs are primary reservoir
- **Transmission:** bite or contact with rabid animal – zoonotic
- **Pathogenesis:** has glycoprotein that binds to nicotinic acetylcholine receptors (“dog has nicotine cigar with crumpled acetyl-cola cans nearby”) in postsynaptic membrane of motor endplate (“socket coming out of ground behind dog”). After replication period of weeks to months, symptoms begin to appear (depending on site of inoculation in relation to CNS).
 - Retrograde movement of virus along peripheral nerves (“bullets traveling up leash backwards to engine”)
 - Replicates in motor neurons (“litter of puppies – replicates – in motor area of car”)
 - Travels to DRG (“exposed roots coming dorsally off the tree”)
- **Disease:** Rabies. As it spreads along the nerves, causes tingling and numbness; once it gets to salivary glands, causes increase salivary production and excruciating spasms of muscles of throat and larynx, causing dysphagia = foaming of mouth (“thief drooling and foaming at mouth”). Signs include sweating and encephalitis (“thief on top of car sweating with red turban on”) and other neurologic symptoms including hydrophobia, seizures, disorientation, hallucination, coma, and death (fatal once the infection reaches CNS)
- **Diagnosis:** eosinophilic Negri bodies found in hippocampal pyramidal cells (“boat named ‘iNTEGRity’ with pink spots with a seahorse for hippocampus and a pyramid tent”) and purkinje cells (“bunjee cords for purkinje, and tree looks like purkinje cells with pink leaves for Negri bodies”)
- **Treatment:** passive immunization with human rabies immunoglobulins given to those bitten by animals suspected to have rabies (“key chain with antibody like keys for passive immunization”) and killed vaccine for active immunization (“tranquilizer with skull and crossbones and syringe”)





FILOVIRUS “Soccer Field-O Virus”



- **General features:** **negative sense ssRNA** (“nighttime moon with warm RNA colors”), **enveloped** (“players jersey is big and enveloping player on the ground”), **helical** (“orange spiral around goal”), **replicates in cytoplasm**, described as lasso shaped
- **Viruses of medical importance:**
 - **Ebola virus** (“E-GOAL-a virus”)
 - **Marburg virus** (“name on star player’s jersey”) **both have similar symptoms**
- **Reservoir:** possible infection by bats and primates (not fully known) (“medics are monkeys, bat hanging from goalpost”)
- **Transmission:** direct contact (blood, secretions) so healthcare workers are at risk (“medics running onto the field”) and caution needs to be taken when disposing of bodies of those infected as virus can spread like wild-fire
- **Disease presentation:**
 - **fever** (“sweating goalie”)
 - **petechial rash** (“on goalkeepers jersey”)
 - **fatal hemorrhagic fever** (“pool of blood under dead player”)
 - **end organ failure** (“kidney and liver shaped spots of blood on dead, lying down player”)
 - **hemorrhagic (hypovolemic) shock** (“lightning bolt on jersey”)
- **Diagnosis:** level 4 isolation, ELISA, PCR
- **Treatment:** supportive and quarantine



BUNYAVIRUS “Paul Bunyavirus”

➤ **General features:**

- **Negative sense ssRNA** (“nighttime moon with warm RNA colors”)
- **Obtains envelope from Golgi body complex of host cells** (“Paul’s robe is gold for golgi”)
- **3 circular segments** (“3 tree stumps with rings for circular”)
- **Arboviruses** (“arbor in background”) **EXCEPT for HANTAVIRUS**

➤ **Viruses of medical importance:**

➤ **Hantavirus** (“ghost mice that haunt”)/ **Sin Nombre:**

- **Reservoir:** deer mouse
- **Transmission:** rodent urine/feces (“rodent feces on ground pooping”)
- **Causes pulmonary edema via capillary leak and pre-renal azotemia** (“Paul’s chest bumped out from respiratory effort, sweat marks in shape of lungs for pulmonary capillary leak, and his kidney shaped canteen is leaking for pre-renal azotemia”) **and hemorrhagic fever** (“blood dripping off his axe”)
- **Diagnosis:** PCR

➤ **California Encephalitis and Rift Valley fever** (“name of school on the right”):

- **Transmission:** Aede’s mosquito (“mosquitos biting the kids”)
- **Causes seizures** (“kids in front of school are shaking in fear”) **and encephalitis** (“red turban on school headmaster”)
- **Diagnosis:** Serology





ARENAVIRUS “Welcome to the Arenavirus”

➤ **General features:**

- **Negative sense ssRNA** (“nighttime moon with warm RNA colors”)
- **Enveloped** (“robes”)
- **Ambi-sense – has ability to encode both positively and negatively** (“challenger has one sword in each hand/ambidextrous for ambi-sense”)
- **Helical capsid** (“spiral banners around columns”)
- **Grainy appearance on EM** (“sandy floor”)
- **2-Segmented** (“2 large rings for each gladiator”)

➤ **Transmission: rodents** (“rodents on the arena floor”)

➤ **Viruses of medical importance:**

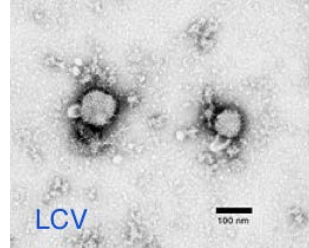
➤ **Lymphocytic Choriomeningitis Virus (LCMV)** (“LCV sign”)

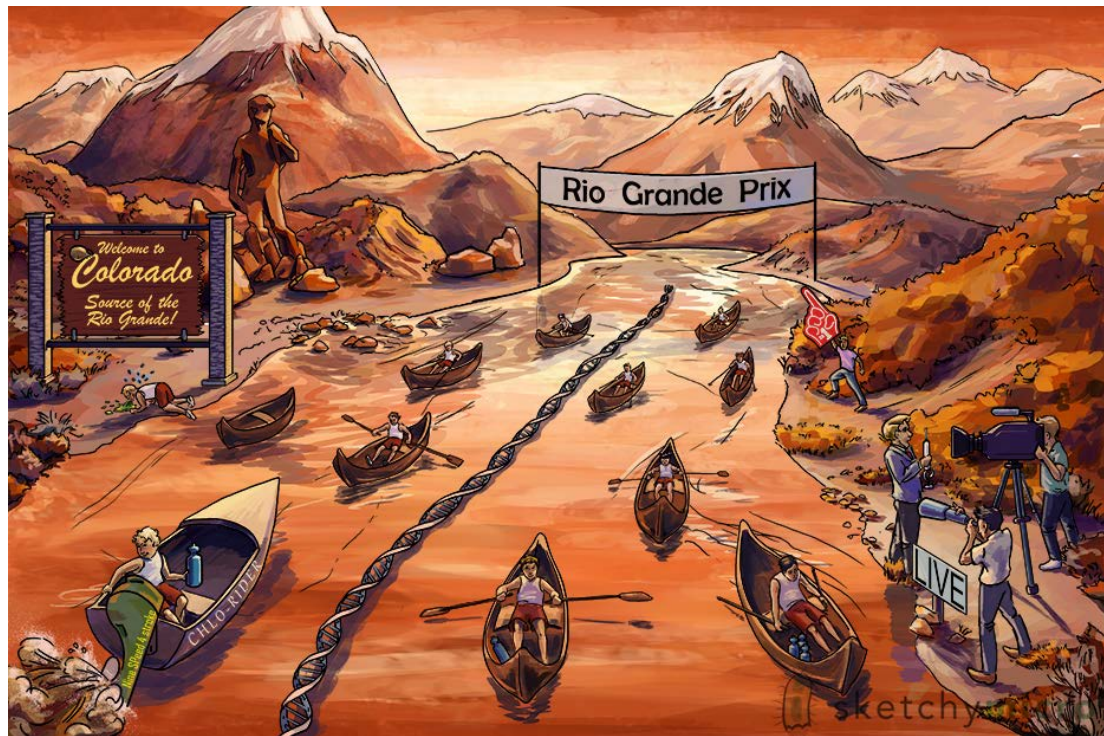
- **Aseptic Meningoencephalitis** (“opponent with red turban wraps around head AND neck”)
- **Fever** (“opponent sweating”)

➤ **Lassa fever: Hemorrhagic fever with 50% mortality rate**

➤ **Diagnosis: serology**

➤ **Treatment: supportive, ribavirin; Virus inactivated by heating, low pH, irradiation, and detergents** (“spear on fire about to inactivate enemy; shield reflecting moonlight for irradiation”)

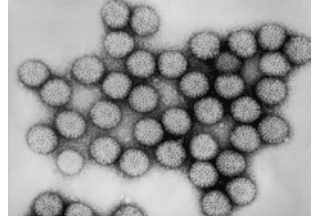




REOVIRIDAE “Rio Grande Prix”

Family characteristics:

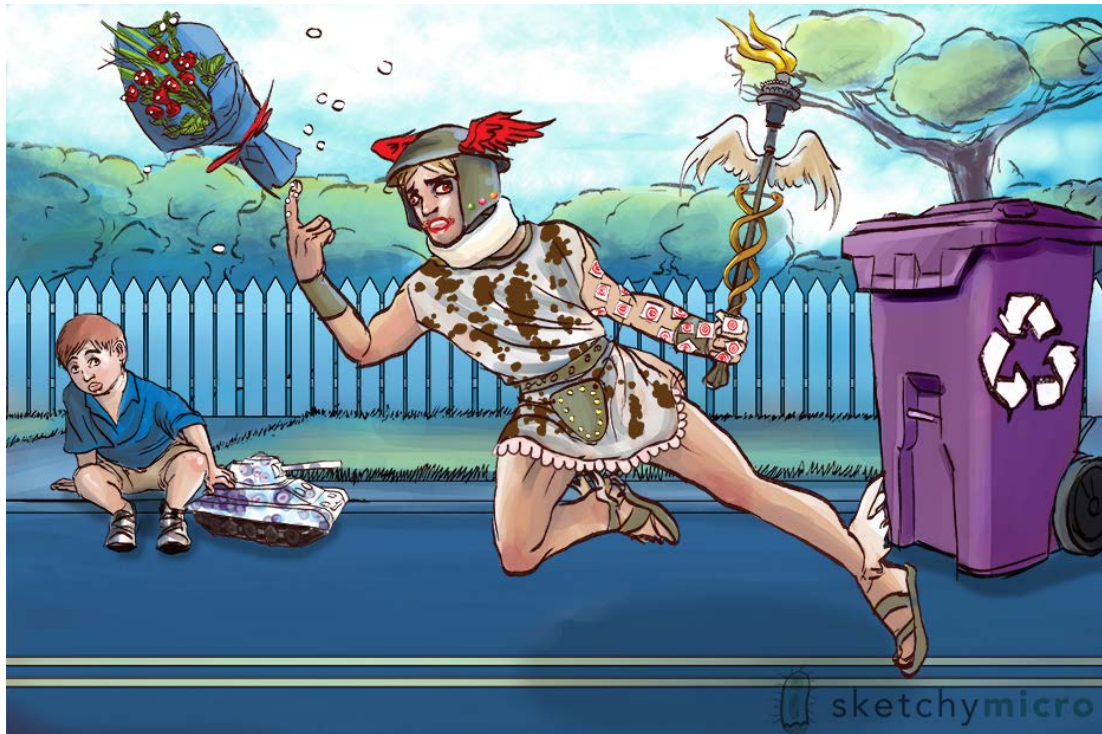
- “Orange tones, but no sun or moon, and presence of double-stranded racing lane” = **double-stranded RNA – dsRNA; both positive and negative sense, replicates in the cytoplasm**
- “Naked statue of David” = **a naked virus, icosahedral shape**
- “11 boats floating on river” = **it has 11 segments**



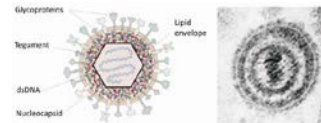
➤ Rotavirus = “row boats”

- **Transmission** – fecal-oral route; NSP4 toxin-mediated, which increases Cl- permeability = “Nine Speed 4 stroke engine on Chlo-Rider boat”
- **Disease** - #1 cause of severe infantile gastroenteritis that leads to watery diarrhea = “child holding a #1 sign and children rowing the boats; the propeller is in muddy water”; **it is typically a seasonal virus** = “snowcapped mountains”
- **Diagnosis** – ELISA (stool)
- **Treatment** – it is self-limiting, supportive care, mainly oral rehydration = “child holding a water bottle”
- **Prevention** – a live attenuated oral vaccine is available = “camera crews with lady holding a syringe as a microphone up to the mouth”; **vaccine needs to be given before 3 months of age or else the increase risk for intussusception** = “one camera one is holding a telescope”

➤ Colorado Tick Fever Virus = “Rio grande starts in Colorado – welcome sign with Tick”; **It affects erythroid progenitor cells and causes flu-like symptoms of myalgia, fever, and vomiting; in 50% cases a rash is present** = “kid puking on the side of the river”



HERPES SIMPLEX VIRUS (HSV) 1 AND 2 “Hermes, the God of Herpes”



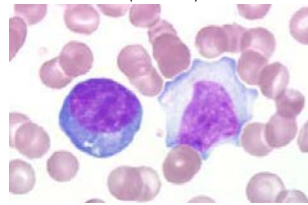
- **Virus Characteristics:** part of Herpesvirus family; large linear dsDNA (“blue tones, double stranded straight road lines”), enveloped (“Hermes wearing a robe”), icosahedral, derives envelope from nuclear membrane, contains intranuclear inclusions bodies aka Cowdry bodies (“robe is of cow hide”); establishes latency
- **Reservoir:** human mucosa and ganglia
- **Transmission:** close personal contact, i.e. kissing, sexual contact, and vertical transmission - a **TORCHES** congenital infection (“Hermes holding a torch” – note **TORCH**, which includes Toxoplasmosis, Other (syphilis, varicella-zoster, parvovirus B19), Rubella, Cytomegalovirus (CMV), and Herpes infections, are some of the most common infections associated with congenital anomalies).
- **Pathogenesis:** HSV establishes infection in the mucosal epithelial cells and leads to the formation of vesicles. The virus travels up the ganglion to establish lifelong latent infection. Stress triggers reactivation of virus in nerves and recurrence of vesicles.
- **Disease:** The rule of thumb is that HSV-1 infections generally occur above the waist and HSV-2 infections generally occur below
 - **HSV-1**
 - **Gingivostomatitis and cold sore (Herpes labialis):** blister like lesions on the oral mucosa (“inflamed lips with ulcers”); **latent in trigeminal ganglion** (“3 gems on Hermes’ helmet”)
 - **Keratoconjunctivitis** (“inflamed eyes”): **generally with lid swelling and vesicles; serpiginous corneal ulcers on fluorescein slit lamp exam seen** (“two twisting serpents around staff”); **dendritic ulcers; untreated and repeat attacks may result in blindness**
 - **Encephalitis due to necrosis and hemorrhage** (“black helmet for necrosis with red wings for hemorrhage”); **focal temporal lesions and perivascular cuffing** (“wings on temporal sides”); **presents with fever, headache, and confusion** (Hermes looks crazy in the eyes”); **if untreated 70% mortality rate; most common cause of sporadic viral encephalitis in the US**
 - **Herpetic Whitlow:** Herpes rash on the fingers, **more common in dentists** (“dew drops on finger”); **Herpes rash has “dew on rose petals” appearance** (“Hermes dropping roses with dew drops”)
 - **Erythema Multiform** may appear 1-2 weeks after infection (“red postage stamps up Hermes’ arm”)
 - **HSV-2**
 - **Genital Infections and Inguinal LAD** (“tufting around hem of Hermes’ robe”); **painful genital vesicles; systemic effects can include fever, malaise, and myalgia; latency in the sacral nerve ganglia** (“triangular, sacral-shaped metal cod-piece”)
 - **Neonatal Herpes:** infection during passage through infected birth canal; infections are usually severe – disseminated with liver involvement and high mortality; encephalitis, also high mortality; affects skin, eyes, or mouth
 - **HSV-2 may cause aseptic meningitis in adolescents and adults** (“neck brace”)
- **Diagnosis:** For oral lesions – clinical; for encephalitis – PCR on CSF with large numbers of RBCs found in CSF; for genital infections – Tzanck smear to show the formation of multinucleated giant cells (“toy Tank painted to look like multinucleated giant cells”) and **Cowdry type A intranuclear inclusions** has been largely replaced by immunofluorescent staining, which can distinguish HSV-1 from HSV-2
- **Treatment:** Acyclovir (“the recycling bin”) is a nucleoside analog that is only activated in cells infected with HSV-1, HSV-2 or VZV. This is because the virus thymidine kinase is required to activate the drug by placing the first phosphate on the drug, followed by the phosphorylation via cellular enzymes. Resistance to acyclovir occurs due to a mutation in the thymidine kinase. Famciclovir, valacyclovir (“violet color to recycling bin”), and penciclovir are alternatives if resistance develops



EPSTEIN-BARR VIRUS (EBV) “Ye Olde Epstein Bar”

- **Virus Characteristics:** part of Herpesvirus family; large linear dsDNA (“blue tones”), enveloped, icosahedral, derives envelope from nuclear membrane, contains intranuclear inclusions bodies aka Cowdry bodies, establishes latency
- **Reservoir:** humans; **transmission:** saliva – 90% of adult population is seropositive
- **Pathogenesis:** virus infects nasopharyngeal epithelial cells, salivary and lymphoid tissues; becomes a latent infection of B cells (“represented by the sleeping protector archer dressed in white with an antibody-shaped arrow”); **EBV binds to CD21** (“‘Must B 21’ sign for drinking”) and acts as a **B-cell mitogen**; this results in the production of the atypical reactive CD8+ T cells, aka **Downey Cells** (“killer knight with T cross on outfit and figure 8’s on shoulder pads and belt reacting to wine being spilled on him; wine stains look like the Downey cells with enlarged cytoplasm and folded nucleus”); **Downey cells may constitute up to 70% of the WBC count**; **Heterophile antibodies are produced due to B cell mitogenesis**
- **Diseases:**
 - **Heterophile-positive Mononucleosis, the kissing disease** (“woman wanting to kiss the guy”): **presents with fatigue, fever** (“man guy about to be kissed sweating”), **sore throat with pharyngitis and tonsillar exudates** (“man drooling”), **lymphadenopathy** (“knight grabbing guy on back of neck”), and **splenomegaly** (“random cow with liver and spleen-shaped spots”)
 - **Lymphoproliferative disease:** occurs in immunocompromised patients; **T cells can’t control the B cell growth**
 - **Hairy Oral Leukoplakia** (“old man in scene with large white beard covering his oral region”): **hyperproliferation of lingual epithelial cells**; occurs in **AIDS or immunocompromised patients** (“cane”)
 - **Associated malignancies:**
 - **Burkitt Lymphoma** (“represented by Bar Kid wearing African garb eating cancer crab puffing cheeks”): **cancer of the maxilla and mandible (Abdomen in Sporadic Form) in African or Endemic form**; **malaria cofactor, targets AIDS patients; (t8;14) translocation** juxtaposes *c-myc* oncogene to a very active promoter, such as an immunoglobulin gene promoter
 - **Nasopharyngeal carcinoma:** predominately found in Asia (“Asian man being pinched by crab”) – **tumor cells of epithelial origin**
 - **Hodgkin B Cell Lymphoma of Mixed Cellularity:** diagnosed with **Reed-Sternberg cells that look like owl eyes** (“painting of owl with large eyes”)
- **Diagnosis:** **Heterophile-antibody positive (IgM antibodies that recognize the Paul-Bunnell antigen on sheep and bovine RBCs); Mono-spot test for rapid diagnosis** (“dart board with darts around the target”)
- **Treatment:** **For uncomplicated Mono, treatment is symptomatic**; if mistakenly given amoxicillin or ampicillin, can develop maculopapular rash (“guy drawing red parks on archer’s face with a pencil”); **avoid contact sports due to risk of splenic rupture** (“‘No Contact Jousting in Bar’ sign”)

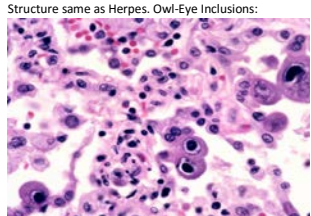
Structure same as Herpes. Downey cell:





CYTOMEGALOVIRUS (CMV) "Cyto Mega-Lo Virus" ("Mega-Lo Prices Grocery Store")

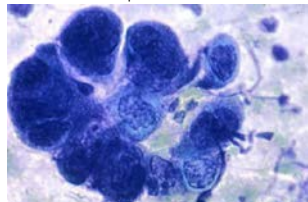
- **Virus Characteristics:** part of *Herpesvirus* family ("Hermes the Herpes God statue on shelf of toys"); **large linear dsDNA** ("blue tones"), **enveloped, icosahedral, derives envelope from nuclear membrane**, contains **intranuclear inclusions bodies aka Cowdry bodies**, establishes **latency**
- **Reservoir:** humans; **transmission:** saliva, sexual, parenteral, in utero
- **Pathogenesis:** CMV infects the **salivary glands epithelial cells** and establishes a **persistent infection in fibroblasts, epithelial cells, and macrophages**; **latency is established in mononuclear leukocytes like B and T cells and macrophages** ("sleeping man next to shelves of T cell knight and B cell archer (from EBV video) and macrophage castle cages"); **reactivation occurs by immunosuppression** ("lady waking sleeping man with immunocompromised cane")
- **Diseases:**
 - **Cytomegalic Inclusion Disease:** **Most common in utero infection in the US; disease ranges from 80-90% infected with no obvious defects** ("80-90% off! sign") **to severe cytomegalic inclusion disease characterized by jaundice and hepatosplenomegaly** ("yellow cow with liver and spleen spots over dairy section"), **thrombocytic purpura with "blueberry muffin rash"** ("boy knocking over display of blueberry muffins"), **pneumonitis, and CNS damage of sensorineural deafness** ("boy covering his ears"), **ventriculomegaly** ("helmet on boy with ventricles venting"), and **periventricular calcifications** ("milk splashed onto helmet") **that can cause seizures** ("man tripping and seizing from spilled milk"); **Hydrops Fetalis in baby** ("red baby balloon in pool of water")
 - **Esophagitis with linear ulcerations** ("conveyer belt with linear streaks to look like the esophagitis") **and CMV colitis with ulcerated walls** ("pink grocery bags lined up to look like haustra of colon with dark spots for ulceration")
 - **Mononucleosis in Children and Adults – heterophile-negative mono** ("boy's mom with red mouth for sore throat holding a 'No Mo Spots' detergent")
 - **Interstitial pneumonitis** ("butcher coughing with lung-stains on apron") **to severe systemic infection, due to reactivation in a transplanted organ patient** ("butcher station full of 'organs'") **or in an AIDS patient**
 - **CMV retinitis: common in AIDS patients with CD4 counts <50; presents with blind spots or vision loss; retinal necrosis and pizza-pie retinopathy seen on funduscopy exam** ("old man with immunocompromised cane next to Charity Drive 50¢ sign holding a pizza box with image of retina")
 - **CMV is #1 cause of sensorineural hearing loss in children AND congenital viral infection** ("#1 symbol on kid's shirt")
- **Diagnosis:** **Owl-eye inclusion = "sight-o-megalo-virus"** ("Owl O's Cereal boxes in seizing person's food basket") **seen on biopsy material and urine; basophilic intranuclear inclusions; serology, DNA detection, virus culture**
- **Treatment:** **in healthy – supportive; in immunocompromised – ganciclovir** ("Cans Only recycling bin") **or foscarnet** ("fast car with net shopping cart") **with human immunoglobulin**. **Resistance to ganciclovir is through UL97 gene** ("UL97 sticker on the fast car net shopping cart")
- **Prevention:** **safe sex practices, screening of blood and organ donors.**





VARICELLA ZOSTER VIRUS (VZV) “Varicella ‘Zeus’-ter Virus”

Structure same as Herpes. Tzank Smear:



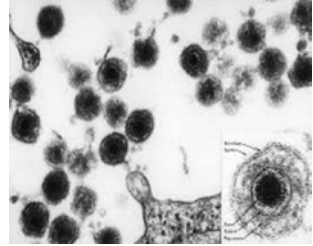
- **Virus Characteristics:** part of Herpesvirus family (“Hermes the Herpes God hanging from tree over stage”); **large linear dsDNA, enveloped** (“Zeus wearing a robe”); **icosahedral, derives envelope from nuclear membrane**, contains **intranuclear inclusions bodies aka Cowdry bodies**; **establishes latency**
- **Reservoir:** human mucosa and nerves; **Transmission:** **respiratory droplets** (“kid shooting water gun”); **vertical transmission - a TORCHES congenital infection** (“Torches at stage corners” – **note TORCH**, which includes *Toxoplasmosis*, *Other* (*syphilis*, *varicella-zoster*, *parvovirus B19*), *Rubella*, *Cytomegalovirus (CMV)*, and *Herpes infections*, are some of the most common infections associated with congenital anomalies.
- **Pathogenesis:** VZV enters the respiratory tract, then replicates in the local lymph nodes, enters primary viremia to go to spleen and liver, then secondary viremia to enter skin, where it creates a rash (“rose petals”), and then enters latency period in the dorsal root ganglia (“woman napping on tree roots that have a dorsal inflection”). **Reactivation of virus due to stress or immunocompromise causes vesicular lesions and sever nerve pain; lesions can occur in different stages of healing** (“All Ages Welcome’ Sign”)
- **Disease:**
 - **Chickenpox** (“chickens by the stage”): **presents with fever, pharyngitis, malaise, rhinitis** (“kids sweating and holding head”); **asynchronous rash forms; one of the 5 “classic” childhood exanthems, but less common due to vaccination. Adult presentation of chickenpox is with pneumonia** (“adult on stage is coughing”) and **encephalitis** (“same adult wearing red turban”); **occurs especially in immunocompromised patients** (“holding a cane”)
 - **Shingles aka Herpes Zoster:** **reactivation of the latent infection occurs in 5th or 6th decade of life, or in immunocompromised patients** (“shingled roof over a group of seniors 60 and over, some holding a cane”); **presents with painful** (“Zeus striking other actor with lightning bolt, symbol for pain”) **vesicles that have “dew drops of rose petals” appearance to one dermatome** (“rose petals being flung at the actor on stage, leaving a smear of dew-covered rose petals”); **rash does not cross the midline unless disseminated in immunocompromised patients; Post-Herpatic Neuralgia is the pain that results after the rash subsides** (“angry man who flung the flowers is shirtless with no rash, but has lightning bolt pain symbol”)
 - **Herpes Zoster Ophthalmicus:** **vision loss is possible when CNV₁ is affected** (“red eye patch”)
 - **Congenital Varicella Syndrome** (“pregnant lady looking at baby-doll”); **presents with limb hypoplasia** (“doll has peg legs and stubby arms”), **cutaneous dermatomal scarring** (“doll’s stuffing coming out in dermatomal distribution”), and **blindness** (“chicken plucking off doll’s eye out”)
- **Diagnosis:** **Tzanck Smear** (“Tank in kid’s hand with multinucleated giant cell paint – also in HSV video”) – **shows Cowdry type A, intranuclear inclusions; also antigen detection by PCR**
- **Treatment:** **Acyclovir** (“recycling bin”); **healthy adults with shingles are given oral acyclovir; immunocompromised are given IV acyclovir; Famcyclovir** (“family with recycling shirts”) **given for ease of dosing; Valacyclovir** (“violet recycling bin”) **can also be used for treatment; note – Aspirin is contraindicated in children after infection due to association with Reye’s syndrome**
- **Prevention:** **live, attenuated vaccine available to both children and seniors** (“‘Live Show’ on Syringe-shaped sign for both children and seniors section”); **booster for 60 year olds to prevent shingles; VZIG (Varicella-Zoster Immunoglobulin) available for postexposure prophylaxis of the immunocompromised; give when CD4 count >200** (“Seat at least 200 sign”)



HUMAN HERPES VIRUS HHV-6

“A Roseola by Any Other Name would smell as Sweet”

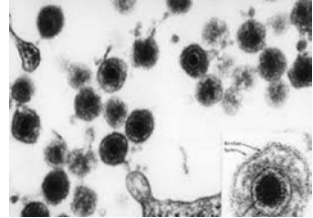
- ***Virus Characteristics:*** part of Herpesvirus family (“Hermes the Herpes God printed on horse with 6 drawn on robe”); **large linear dsDNA** (“blue tones”), **enveloped, icosahedral, derives envelope from nuclear membrane, contains intranuclear inclusions bodies aka Cowdry bodies, establishes latency**
- ***Reservoir:*** humans; ***transmission:*** respiratory droplets
- ***Pathogenesis:*** replicates and infects peripheral blood mononuclear cells, mainly CD4+ T-helper cells (“squire is helping his knight; has 4 feathers in his hat and a #4 on his belt”)
- ***Disease:*** **Roseola (exanthema subitum)** (“field of roses and rosary in squire’s hands”); **presents with a high temperature fever for 3-5 days** (“squire is sweating profusely; over his head is a flag with fun suns to represent approximately 4 days”); **fever can lead to a febrile seizure** (“squire is trembling from fear as he sees an apparition”); **once fever subsides** (“apparition surrounded by blue flames”), **a lacy body rash appears that spares the face** (“apparition is wearing a lacy pink dress that does not go over her face”); **disease primarily affects children 6 months – 2 years old** (“represented by baby in apparition’s arms”)
- ***Diagnosis:*** Clinical
- ***Treatment:*** Symptomatic, supportive





HUMAN HERPES VIRUS HHV-8 “Ring Around a Ka-Posi”

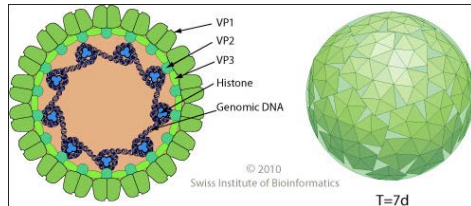
- **Virus Characteristics:** part of *Herpesvirus* family (“Hermes the Herpes God on doors with 8’s around him”); **large linear dsDNA** (“blue tones”), **enveloped, icosahedral**, derives envelope from nuclear membrane, contains **intranuclear inclusions bodies aka Cowdry bodies**, establishes latency
- **Reservoir:** humans; **Transmission:** sexual contact, saliva, vertical, transplantation; Higher incidence in Russian men and African populations (“Maps of Russian Rhododendrons and African Azaleas”) and in the **immunocompromised and AIDS patients** (“old lady with immunocompromised cane and AIDS support ribbon”)
- **Pathogenesis:** HHV-8 has a gene that turns on **vascular endothelial growth factor (VEGF)**, which plays a direct role in the development of **Kaposi Sarcoma** (“VEG Fertilizer with red branching plant for angiogenesis”)
- **Disease:**
 - **Kaposi Sarcoma** – erythematous, violaceous lesions on the nose, extremities, and mucous membranes (“old lady holding bouquet of violet flowers with petals on her nose and extremities”); **because mucous membranes are affected, lesions can be found in the GI tract** (“transparent plant covering that looks like the intestines”) **but more commonly found on the hard palate** (“roof of greenhouse like roof of mouth covered with violet lesion roses and vines”); lesions may be present as a **plaque, patch, macule, or nodule**, and they arise from primitive vascular forming mesenchymal cells – pathogenesis involves angiogenesis (“worker unwinding red watering hose”) **where newly created blood vessels within the lesions cause the violaceous color.**
 - **Primary Effusion Lymphoma:** HHV-8 can also infect B cells and cause this B cell lymphoma (“‘B’ rating for the store next to the B-cell archer symbol”)
- **Diagnosis:** clinical, serology, PCR; Kaposi sarcoma can be confused with bacillary angiomatosis from *B. henselae* (“Bart the Leopard from the *B. henselae* video looking in to greenhouse”)
- **Treatment:** none





POLYOMAVIRUS BK AND JC “Et Tu, BK?”

- **Virus Characteristics:** naked (“Statue of David”), dsDNA (“blue overtones, dsDNA around the room”), **circular** (“round senate room”)



Virus	BK (“Brutus’ Kinfe”)	JC or John Cunningham (“Julius Cesear”)
Reservoir/ Transmission	Respiratory	
Disease/ Pathogenesis	Renal Disease (“knife is stabbing flank region”) caused by latent infection in the kidney; hemorrhagic cystitis (“cherub statue peeing red over fountain labeled BK”) particularly in transplant patients (“statue next to tray of organs falling on floor”)	Progressive multifocal leukoencephalopathy, PML (“Cesar’s bust is labeled with PML”); caused by infection in oligodendrocytes causing demyelination throughout the CNS (“wood peeling off of table legs shaped like myelinated axons”); leads to non-enhancing multifocal brain lesions in white matter (‘crown of white leaves on Cesar”); occurs mainly in AIDS or immunocompromised patients (“JC with AIDS support ribbon and holding cane”) with CD4 count <200 (‘“Senator Count 200’ sign”)
Diagnosis	ELISA, PCR	
Treatment	Supportive	



HUMAN PAPILLOMA VIRUS - HPV “Pilloma Bugs”



- **Virus Characteristics:** dsDNA virus (“blue overtones”), circular, naked (“Statue of David”), icosahedral, over 75 serotypes – 6 important ones are associated with different clinical presentations
- **Reservoir:** human skin and genitals; **Transmission:** direct contact, fomites
- **Disease and Pathogenesis:**
 - For HPV serotypes 1-4 (“represented by the two little infants holding up 1 and 4 fingers”): cutaneous warts – the virus infects basal layer of the skin and mucous membranes; hyperkeratosis leads to the formation of the “wart” – common warts (serotypes 2, 4) are predominantly found on the hands and fingers; plantar warts (serotype 1) are predominately found on soles of feet and tend to be deeper and more painful (“pill bugs all over the children’s bodies”)
 - For HPV serotypes 6 and 11 (“represented by the two kids wearing a 6 and 11 on shirts”): laryngeal papillomas aka recurrent respiratory papillomatosis (“kid putting a pill bug down his throat”) – affects infants and sexually active adults. Also causes anogenital warts (“other kid putting pill bug down his pants”) aka Condylomata acuminata (“that kid is standing next to a jar of an accumulation of pill bugs”) – over 90% of genital warts are serotypes 6 and 11; benign warts
 - For HPV serotypes 16 and 18 (“the 16 represented by a 16 year old who just got his license so has his car keys and the 18 represented by an 18 year old who has her ‘Just Voted’ sticker”) and to less extent, serotypes 31 and 33 (“add 15 years to these teenagers”): preneoplastic – malignancy may result (“the two are enjoying a crab luncheon – crab is sign for cancer”): E6 inhibits tumor-suppressor gene p53, which stops the transition from G1 to S phase (“fork with E-shaped prongs on 6-shaped shrimp next to a crab cracker with check-point red and black striped handle that is over a light to dark blue transition on the table”) and E7 inhibits tumor-suppressor gene Rb (“fork with E-prongs next to 7-shaped straw in a root-beer for retinoblastoma protein, Rb”) – cause anogenital cancers (“teen about to sit on a pill bug in his chair”) or cervical intraepithelial neoplasia, CIN; 95% of cases of CINs contain HPV DNA
 - Is an AIDS-defining illness (“young woman with AIDS support ribbon on shirt”); immunosuppression increases the risk of HPV-related cancers (“young woman with broken leg standing next to immunocompromised cane”)
- **Diagnosis:** on cutaneous warts – clinical grounds; on genital warts – finding of koilocytic cells (“young woman standing over a plate of blue sunny-side up eggs that look like koilocytic cells), which are cells with perinuclear cytoplasmic vacuolization and nuclear enlargement, in Pap smears (“young woman has a smear across her face”); in situ DNA probes and PCR can be used to confirm any diagnosis and type the HPV strain involved
- **Treatment:** Cryotherapy, electrocautery, or chemical means (salicylic acid); imiquimod (induces proinflammatory cytokines), interferon-alpha, and virus-specific cidofovir
- **Prevention:** Gardasil vaccine is an inactivated subunit vaccine composed of HPV capsid proteins produced by recombinant DNA technology (“syringe-spikes on the guard fence”); vaccine covers serotypes 6, 11, 16, and 18 (“those not in the fence – 1-4 and 31, 33 – are not included”); also safe sex practices will help prevent

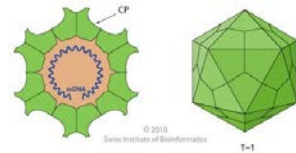


sketchymicro

PARVOVIRUS B19 “Bombs Away!”

(“setting is playroom with a boy playing with a model B19 bomber airplane”)

- **Virus Characteristics:** ssDNA (“a single lane runway strip”), **linear**, **Naked** (“boy holding toy statue of David”), **icosahedral**; **smallest virus** (“kid playing over a small toy town”)
- **Reservoir:** human respiratory tract
- **Transmission:** respiratory route (“kid squirting a water gun”), **fomites – naked viruses last a while on fomites**, **vertical transmission – mother to fetus**, **a TORCHES congenital infection** (“toy Statue of Liberty with torch” – note **TORCH**, which includes *Toxoplasmosis*, *Other* (*syphilis*, *varicella-zoster*, *parvovirus B19*), *Rubella*, *Cytomegalovirus* (CMV), and *Herpes* infections, are some of the most common infections associated with congenital anomalies).
- **Pathogenesis:** B19 infects immature (cycling) erythroid progenitor cells, resulting in cell lysis. The resulting anemia is only clinically significant in patients with sickle cell anemia (“communist plane in the cupboard with sickle symbol”) and may result in aplastic crisis, which involves a depletion of bone marrow; the bone marrow is left with adipocytes that when packed together have a cob-web look (“cob-web around the bone under the communist plane”)
- **Disease/ Organs Most affected:**
 - In Children/ Adults: **Slapped Cheek Fever** (“one kid slapping another on the cheek”) aka **Fifth Disease** (“the slap leaves a 5-finger imprint on the cheek”); **an erythema infectiosum – a low grade fever occurs, breaks, and develops a raised, indurated rash that starts on the face and moves downward** (“kid being slapped holding a plane with flames starting at the face of the plane”); **has a 7-10 day incubation; in adults predominately, can leave rash and arthralgias – joint pain, arthritis, and edema** (“adult in scene in pain from kneeling over legos”) – **due to immune complexes, type III hypersensitivity, in the skin and joints**
 - In fetus: **causes severe anemia, CHF, hydrops fetalis** (“red balloon baby being sprayed by the water gun”); **spontaneous abortions**
- **Diagnosis:** Serology and molecular analysis – obtain based on clinical presentation
- **Treatment:** supportive care; self-limiting





ADENOVIRUS “A Den O-Lions”

- **Virus Characteristics:** Naked (“Statue of David”), **dsDNA** (“blue overtones”), **hexons**, **pentons**, and **fibers**; 49 serotypes
- **Reservoir:** ubiquitous in humans and animals
- **Transmission:** **respiratory droplets** (“dripping stalactites”), **fecal-orally** (“piles of poop around lions”), **direct contact**
- **Pathogenesis:** **penton fibers** act as **hemagglutinin**, **purified penton fibers** are **toxic to cells**; virus is **lytic** in **permissive cells** and can be **chronic** or **oncogenic** in **nonpermissive hosts**. The adenoviruses are the standard example of a **permissive host**, where virus is produced, and **nonpermissive host**, where the virus is not produced, but transformed.
- **Disease/ Organs Most affected:**
 - **Most common cause of infection in adenoids and tonsils, tonsillitis** (“scene set to look into back of a red cave like looking into an inflamed throat; lions yawning with throats exposed”)
 - **Acute Respiratory Disease (ARDS) and pneumonia: spring and winter peak incidence; in children, young military recruits, and college students** (“child wearing camo shirt watching the lions”) – **serotypes 4, 7, and 21**
 - **Pharyngoconjunctivitis** (“lions’ red eyes in back of cave, and lion cubs with pink eyes rolling around in poop”): **causes swimming pool conjunctivitis** (“kid swimming in pool of water”), **pink eye**; also presents with **fever, sore throat, coryza, and red eyes; nonpurulent**
 - **Acute Hemorrhagic Cystitis** (“Statue of David peeing red”); **occurs in boys ages 5-15 predominantly; presents with dysuria and hematuria**
 - **Gastroenteritis:** occurs in day care, but not as common as rotavirus; from serotypes 40, 41
- **Diagnosis:** serology, ELISA
- **Treatment:** supportive care
- **Prevention:** a live, nonattenuated vaccine is available for military recruits (“kid in camo holding a syringe in front of the sign, ‘A Den of LIVE Lions’”)

Structure Of Adenovirus

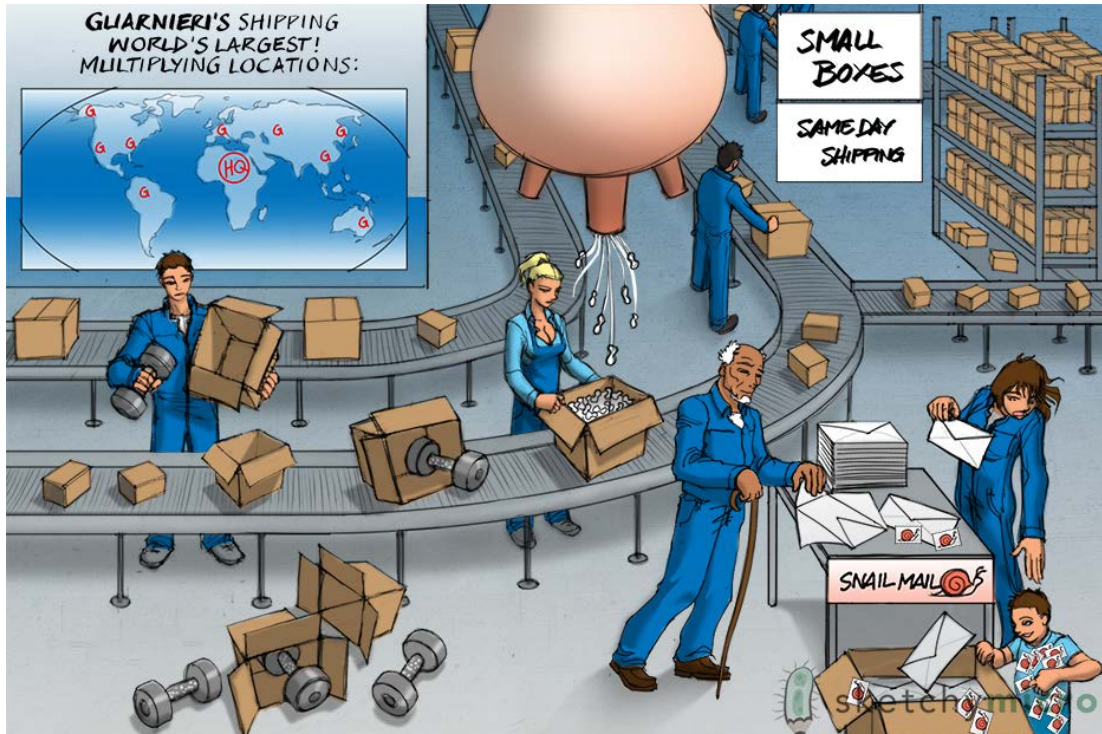


**GUARNIERI'S SHIPPING
WORLD'S LARGEST!
MULTIPLYING LOCATIONS:**



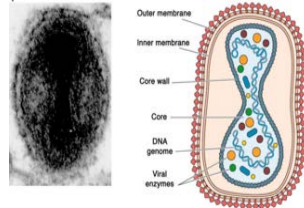
**SMALL
BOXES**

**SAME DAY
SHIPPING**



POX VIRUS “Small Boxes”

- **Virus Characteristics:** dsDNA (“blue tones”), can make its own envelope (“workers making envelopes”), has complex morphology, only DNA virus that replicates in the cytoplasm and has own RNA polymerase and everything it needs to replicate outside the nucleus (“Pox in a Box theme, workers stuffing boxes”), has **Guarnieri bodies**, or **inclusion bodies**, which are sites of viral replication in the cytoplasm (“map of world with Hq representing the nucleus and the G’s indicating the sites outside the nucleus in the cytoplasm with ‘Guarnieri’s Shipping’ sign over map”), **dumbbell shaped core** (“dumbbells in boxes”), **largest known DNA virus** (“‘World’s Largest!’ in sign”); has potential to be biowarfare agent



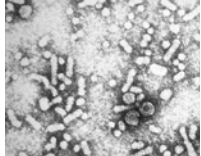
Viruses of Medical Importance:

Virus	Variola/ Smallpox (“Small Boxes”)	Molluscum contagiosum (“Snail Mail”)
Reservoir	Humans; Variola has 1 sterotype, which made eradication in 1977 possible	Humans
Transmission	Respiratory Route	Direct contact (sexual) and fomites
Pathogenesis	Via inhalation, the virus enters the upper respiratory tract and disseminates via lymphatics causing viremia; after a secondary viremia, the virus infects all dermal tissues and internal organs; creates classic “pocks”	Replicates in dermis; Single or multiple (<20) benign, wart like tumors that appear flesh colored, dome shaped, and umbilicated on the skin (“lesions look like the snail’s shell”); affects the trunk region in children (“kid covered in snail stamps only on his body”); diffuse infection in adults suggest an HIV infection (“elderly man holding cane”)
Disease	Has 5-7 day incubation period; prodrome of flu-like illness for 2-4 days; prodrome is followed by a rash, which begins in the mouth and spreads to the face, arms and legs, hands, and feet and can cover the entire body within 24 hours; all vesicles are in the same stage of development – synchronous rash – as opposed to the nonsynchronous <i>Varciella</i> chickenpox rash (“Same Day Shipping”)	
Diagnosis	Clinical; Guarnieri bodies found in infected cells (intracytoplasmic)	Clinical, eosinophilic cytoplasmic inclusion bodies
Treatment/ Prevention	Supportive Care; live, attenuated vaccine available – made from cow pox strain, which protects – allowed for eradication	In healthy – self-limiting; Ritonavir, cidofovir in the immunocompromised

- **Cow Pox:** is transmitted via contact with infected cow utters (“Styrofoam dispenser shaped as cow utters”); cow pox was found to be protective against small pox



HEPATITIS B “Hep B Love”



- **Description:** **Hepatitis Virus** (Hippie Van that looks like a hippo). **Hepadna Virus Family** (Hippie Pad). **DNA virus** (cool colors of blue and purple). **Enveloped** (Hippies in flowy robes). **Replicates in and outside the nuclus** (nucleus shaped hippie pad with person peaking out). **Circular DNA and partially double-stranded** (circle with hippies and a partial 2nd outer circle). **Uses reverse transcriptase** (Reverso Transcripto spell book) **to go from a partially double stranded DNA to and intermediate single stranded RNA, then back to a double progeny DNA.** **Does NOT integrate into the host chromosome, therefore NOT a retrovirus.**
 - **Transmission:** **Sex, sharing of blood products or needles, and vertical transmission.** (sign: Sex Drugs and Rock and Roll, mother with baby for vertical transmission and red tie die dress suggesting blood during delivery). **TORCHES infection** (tiki torches around mother and baby).
 - **Disease/ Organs Most affected:**
 - **Hepatitis both acute and 5-10% chronic, except newborns have about a 90-95% chance of developing chronic infection** (mother and baby eating cooking, mother has about 10%, baby has 90% of the cookie).
 - **Prodromal serum sickness w/ rash and arthralgia** (henna representing the purpuric rash, and pain lines around knees)
 - **Glomerular nephritis** (kidney shaped bead boxes). **2 forms: Membranous glomerular nephritis** (2 string thick knot representing the thickened glomerular membrane) **and membrano-proliferative glomerular nephritis** (3 string knot representing the deposits in the mesangium expanding into the glomerular membrane causing a tram-track appearance)
 - **Polyarthritis nodosa – systemic vasculitis effecting medium to small arteries** (beaded necklace since the small aneurysms have a beads on a string appearance).
 - **Long term consequences – liver cirrhosis** (liver shaped rock) **and hepatocellular carcinoma** (tarot card with cancer crab)
 - **Diagnosis:**
 - **ALT rises during acute infection and then falls close to normal after symptomatic phase** (volleyball going up and then down). **Neonate babies often have normal ALT levels** (baby with deflated ALT ball).
 - **Antigens. Need to be able to understand the antigen titer at different stages of disease** (side of van with lines showing titer volumes)
- | Symptomatic phase (over flat tire) | | Recovered or Immunized | |
|------------------------------------|--|--------------------------------|--|
| Surface antigen | Active disease and first to be measurable. | Anti-HBcore Ab (yellow) | During window period (notice in window of van), still infected. |
| Envelop antigen | Highly correlates with infectivity. | Anti-HBenvelope Ab | Immunized people would be neg. |
| | | Anti-HBsurface Ab | Indicates recovery or vaccination. (line wrapped around syringe) |
- **Hepatitis D:** **Cannot cause disease without HepB.** **RNA virus** (children dressed in orange). **Enveloped** (flowy hippie clothes). **RNA (-)** (necklaces with moons). **Circular genome** (circular headbands). **Require HBsAg to be infectious** (mother putting flair on kids). **Co-infection** (child next to father holding hands) **and super-infections which have worse outcomes** (child on father's shoulders and he is grimacing from weight).
 - **Treatment:** **Lamivudine** (lamb in make peach not war), **Nucleoside reverse transcriptase inhibitors** (war elf from HIV video), **Interferon alpha** (van antenna twisted into an alpha). **Give at risk kids anti-HepB immunoglobulins** (kid with keys shaped like IgG).

parasite



GIARDIA LAMBLIA “The Giardia Jungle Ride”

Protozoan Luminal Flagellate

- **Transmission:** transmitted in cyst form (“cysts are represented as bubbles downstream”); **route is fecal-orally by poorly purified water, food, in day care, or oral-anal sex** = “scene is set with kids camping down a stream where there is a poop floating in it; the campers are drinking from the stream”
- **Disease/ Organs Most affected:** Giardiasis – the organism have a “falling leaf” motility; the ventral sucking disk of the organism attaches to the lining of the duodenal wall and does not invade (“the trophozoite-shaped shields are attached to the boat”); **this causes a foul-smelling, fatty diarrhea - steatorrhea** (“represented by a kid sitting on a yellow, fatty stool, and the other campers holding their nose at the smell”); **this is due to malabsorption in the small intestine and so you’ll also have Vitamin A,E,D, and K malabsorption.**
- **Diagnosis:** the trophozoites or cysts are seen in the stool on fecal antigen test (“a man with an OP – for ova and parasite screening – shirt is pointing at the trophozoite shields that have fallen into the river, representing trophozoites that get into feces”); **an ELISA is also used to screen** (“the boat is named ELISA looking for the trophozoites”)
- **Treatment: Metronidazole** = “monorail/ or metro train pictured in the background”

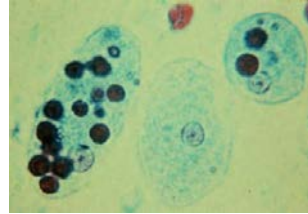




ENTAMOEBA HISTOLYTICA “Entering the Historical Dig”

Protozoan Amebae

- **Transmission:** transmitted in cyst form (“cysts are represented as bubbles in a puddle”); **route is fecal- orally by water, fresh fruits and vegetables, and oral-anal sex** = “scene is set with archeologists drinking from bubble pond, two of whom are gay men holding hands”
- **Disease/ Organs Most affected:** **Inverted flask-shaped lesions** (“men drinking from Erlenmeyer flasks”) in large intestine with extension to peritoneum and liver, lungs, brain, and heart; **right lobe of liver is the most common site for an amoebic liver abscess to form** (“map of site is shaped as a liver with a tomb in the right lobe”); **liver abscess is described as having an “anchovy paste” consistency** (“represented by anchovy paste trunk”); **patients present with RUQ pain** (“man standing in tomb holding RUQ”); **produces blood and pus in stools** (“archeologists sitting on red stools”); **altogether this is Amebiasis dysentery, kind of like dysentery from EIEC or Shigella dysenteria – an invasive and inflammatory diarrhea that causes ulcers on the mucosa** (“represented by colon shaped drain pipe with rust spots draining brown diarrhea water”)
- **Diagnosis:** the trophozoites or cysts are seen in the stool on fecal antigen test (“OP written on the drain pipe – for ova and parasite screening”); **the nuclei have sharp central karyosome and fine chromatin “spokes”**; **the organism has endocytosed RBCs** (“represented by the red solo cups in a second puddle that looks like the trophozoite”); **an ELISA is also used to screen.**
- **Treatment:** **Metronidazole** = “metro train pictured in the background” **followed by iodoquinol** (“Queen Iodo sign and head at the tomb site”), **or paramycin** (“a luminal agent shown as a pair of mice coming out of the tunnel”)



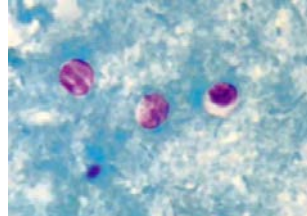


sketchy**micro**

CRYPTOSPORIDIUM – C. PARVUM “Tales from the Crypt”

Protozoan Intestinal Apicomplexa

- **Transmission:** transmitted in cyst form (“cysts are represented as bubbles in the pool of the crypt”); route is orally by undercooked meat, swimming in dirty water, and animal-handlers; organism not killed by chlorination
- **Disease/ Organs Most affected:** Cryptosporidiosis is a transient diarrhea in healthy individuals, but a severe watery diarrhea in immunocompromised, such as HIV/AIDS, hosts (“man shown with immunocompromised cane standing in stagnant, poop water”); the cysts are composed of 4 motile sporozoites (“amethyst crystals”) that attach to the intestinal wall and cause small intestine damage and diarrhea (“drain pipe that looks like SI draining brown, muddy water”)
- **Diagnosis:** the oocysts in the stool stain acid fast (“represented by pink pancho and amethyst crystals”); biopsy shows dots in intestinal glands that are nice and round
- **Treatment:** Nothing is 100% effective; usually it is self-limiting so rehydrate; nitrazoxanide (“knitted socks”) is DOC; filtration can remove oocysts from infected water as good prevention (“water dripping from the knitted socks”); another medication that is not FDA approved is spiramycin, a macrolide (“spirit crows in the background”); other medications include puromycin or azithromycin





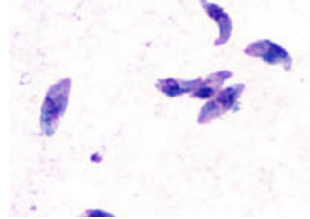
sketchy**micro**

TOXOPLASMA GONDII “Oh Hi, Iz Makin Sum Toxo”

Protozoan Apicomplexa found in Blood/ Tissue

➤ **Disease/ Organs Most affected:**

- In Healthy individuals: *Toxoplasma* acquired after birth is most commonly asymptomatic or a mild, non-specific flu-like illness with lymphadenopathy and fever; heterophile negative mononucleosis; once infected, as immunity develops, bradyzoites encyst, but generally remain viable as evidenced by a positive antibody titer
- In Pregnant patients (“our crazy cat lady is pregnant”): women who acquire *Toxoplasma* as a primary infection during pregnancy present with flu-like illness/ heterophile negative mononucleosis; if primary infection occurs during pregnancy, the fetus may be infected. If *Toxoplasma* crosses the placenta early, severe congenital infections (intracerebral calcifications (“kitten drinking milk with milk splashed on head”), chorioretinitis (“camera flash bulb looks like grainy fundus”), hydro-or microcephaly or convulsions (“bowl of water on another kitten’s head trying to shake it off”)) may occur. Can also present with deafness (“Deaf Beethoven Cat”). If *Toxoplasma* crosses the placenta later, infection may be inapparent, but may lead to progressive blindness in the child in teen years. Maternal antibodies (secondary infection) protect the fetus during pregnancy, even if the mother is re-exposed during pregnancy.
- In AIDS patients or the immunocompromised (“poorly sickly cat holding immunocompromised cane wearing Gondi’s glasses”): *Toxoplasma* infection is the leading cause of focal CNS disease encephalitis in AIDS patients (“sickly cat has a red turban”); brain scan will describe ring-enhancing lesions (“sickly cat with Gondi’s glasses has extra lens-rings”). Brain biopsy is used to differentiate from CNS lymphoma (“biopsy pin in the turban”). Unless prophylactic drugs are given, AIDS patients who are seropositive for *Toxoplasma* will have reactivational infections. Prophylaxis should be given when CD4 count falls <100 (“cat as Benjamin Franklin with immunocompromised cane holding a \$100 bill”) and is seropositive for IgG (“kite with positive sign and IgG antibody key”); prophylactic drug is TMP-SMX (“sulfur egg”).



- **Transmission:** Cat is the essential definitive host; many other animals are intermediate host. Mode (1) Cysts can be present in undercooked meat in the US - #1 is pork (“bowl of bubbly meat knocked over by sickly cat”) (2) Contact with cat feces that contains oocytes (“pregnant lady changing the litter box, holding a poop scoop with cat feces; litter box contains a fallen egg to indicate oocytes in feces”); a ToRCHeS infection – one of the most common infections associated with congenital anomalies (“cat dressed as statue of liberty holding a torch”)
- **Diagnosis:** serology; high IgM or rising IgM in acute infection, cysts found intramuscularly
- **Treatment:** Sulfadiazine (“dyed sulfur Easter eggs”) and Pyrimethamine (“Easter eggs also have pyramids on them”)



TRYPANOSOMA BRUCEI GAMBIENSE AND RHODESIENSE

“Prince Bruce to the Rescue”



Protozoan Hemoflagellate

- **Disease/ Organs Most affected:** African Sleeping Sickness (“sleeping beauty with map of Africa over bed with Gambia and Rhodesia – old name for Zimbabwe – pinned”) aka **African Trypanosomiasis**; causes **cervical and axillary lymphadenopathy** (“girl wearing pearls and ruffles on sleeves”), **fevers, chills, anorexia, and confusion** – fevers can be **undulating** (“undulating hills in the background”)
- **Vector/Form/Transmission:** **trypomastigote in saliva of tsetse fly** (“tea pot and cup of tea with fly in it”) **contaminates the bite**. The parasites are **motile with flagella** (“long pink ribbon in girl’s hair”); has **variable surface glycoprotein coats that undergo constant antigenic variation to evade the immune system and cause chronic infection** (“camp of tents outside of varying colors”)
- **Reservoirs:** humans, some wild animals
- **Diagnosis:** **Trypomastigotes** (“stuffed goat”) in **blood films** (“pricked finger dripping blood”), **CSF** – **high immunoglobulin levels in CSF**
- **Treatment:** for acute – **suramin** (“Prince Bruce coming to wake sleeping beauty with a bottle of serum”); for **chronic and CNS infection** – **melarsoprol** (“Prince Bruce holding a bar of soap, too”)

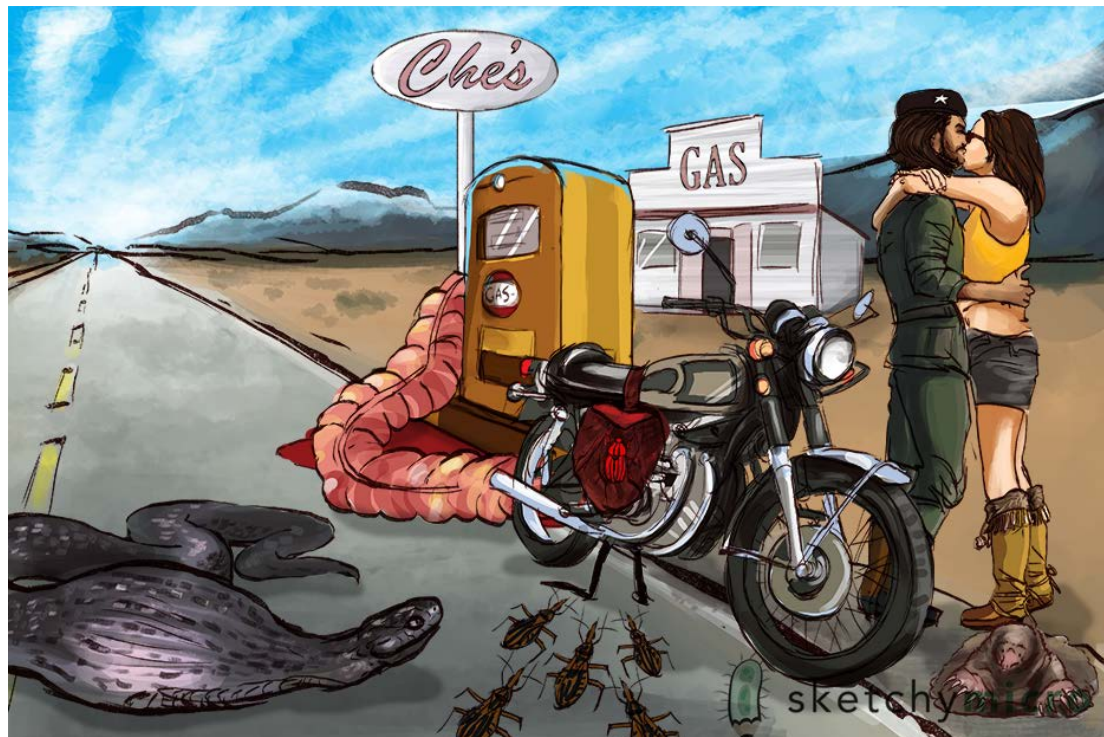


NAEGLERIA FOWLERI “Naegleria Falls”

Protozoan Amebae

- **Disease/ Organs Most affected:** Primary amebic meningoencephalitis (PAM) – presents with severe prefrontal headache, nausea, high fever, nuchal rigidity, and altered sense of smell (“Barrel rider in the front with a red turban for encephalitis and a neck brace for nuchal rigidity of meningitis”); **infections is often fatal** (“face down dead barrel rider who hit his head on a rock”)
- **Form/ Transmission:** Free-living amebae picked up while swimming or diving in very warm fresh water, like lakes (“scene is set at Niagara Falls, a body of freshwater”); **con contaminate water supplies, so can be associated with nasal irrigation systems and contact lens solution** (“two men in front holding water bottles”); **is also associated with patients involved in water sports** (“man sail-surfing”); **organism travels up the nose and through the cribriform plate to enter the CNS** (“barrel riders coming down the falls are in crib-shaped barrels”)
- **Diagnosis:** Motile trophozoites in CSF after lumbar puncture (“Woman barrel rider holding a champagne bottle with a spinal-needle-shaped corkscrew; also called ‘champagne tap’ if free of RBC”); **culture on plates seeded with gram- bacteria – amebae will leave trails**
- **Treatment:** Amphotericin B, but is rarely successful (“the amphibians –for amphotericin - surrounding the surviving, but ill barrel rider”)



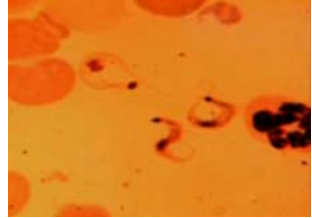


sketchy

TRYPANOSOMA CRUZI “Cruzin’ Through Che’s Gas”

Protozoan Hemoflagellate

- **Disease/ Organs Most affected:** Chagas Disease (“Che’s Gas”) aka American Trypanosomiasis, with high incidence in Latin America. A common early sign includes swelling around the eye (Romana sign). Symptoms also include dilated cardiomyopathy (“floppy heart-shaped saddle bag on motorcycle”), megacolon (“gas pump line shaped like megacolon”), and mega-esophagus (“snake with enlarged esophageal portion”). Liver and brain also often involved.
- **Vector/Form/Transmission:** Reduviid bug aka kissing bug aka cone bug (“bugs drawn on the ground; red bug on heart bag; motorcyclist kissing”); painless bite occurs around the mouth and genus passes trypomastigote (flagellated form) in feces – scratching at infection site implants organism into mucosa. Organism can burrow into the endocardium (“mole tunneling”); trypanosomes can therefore be seen within cardiac myocytes on heart biopsy (“red bug on heart bag”)
- **Reservoirs:** cats, dogs, armadillos, opossums, poverty-housing
- **Diagnosis:** Blood films with trypomastigotes (“gas line leaking, leaving blood-red smear”)
- **Treatment:** Benzimidazole, **Nifurtimox (“girl friend wearing knee-high furry moccasins for Knee-Fur-ti-Moccs...”)

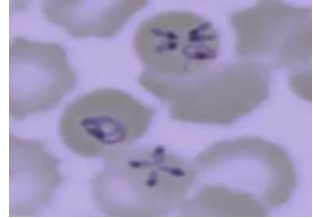




BABESIA “The Vampire Babes”

Protozoan Apicomplexa found in Blood/Tissue

- **Species:** in humans – *Babesia microti*, WA1, & MO1 strains
- **Disease/ Organs Most affected:** Babesiosis – causes blood related (“scene is set with vampires”) **symptoms of hemolytic anemia** (“red stain-glass windows that are shattered”), **hemoglobinuria, resulting jaundice** (“vampire babe in yellow underneath shattered red windows”), **and irregularly cycling fevers** (“Robin of Ixodes captive and sweating with jagged shirt hem”); **is malaria-like, but is often a co-infection with Lyme/ *Borrelia* infection; location is in same range as Lyme disease – NE, N Central, California, and NW US** (“Maltese cross on floor pointing NE”); **higher risk of severe disease in patients with sickle cell disease** (“queen vampire holding a sickle”) **or asplenia** (“Robin’s tunic has a spleen-shaped hole”)
- **Transmission:** *Ixodes* Tick, a deer tick (“two shields with Tick coat of arms and antlers hanging in back; Robin of Ixodes from *Borrelia* video has been captured”)
- **Diagnosis:** **Giemsa stain of thin blood smear** (“blood-red carpet across the floor”) **or hamster inoculation; small rings of Maltese cross formation from tetrad of trophozoites in RBC** (“Maltese cross in middle of floor”)
- **Treatment:** **Clindamycin or azithromycin** (“macrolide crows on queen’s shoulders”) **and atovaquone** (“ato-vampire queen”)



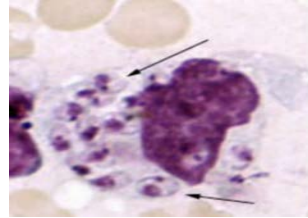


LEISHMANIA SPECIES “Desert Mania”

Protozoan Hemoflagellate

General Features:

- **Vector/Form/Transmission:** sandfly bite (“flies swarming zombie in desert scene”)
- **Reservoirs:** urban – humans; rural – rodents and wild animals
- **Diagnosis:** Amastigotes in macrophages in lesions (“macrophage cages with goats; goats have amastigote-looking spots”)
- **Treatment:** stibogluconate sodium (“T-BOne steak”)



LEISHMANIA BRAZILIENSIS

- **Disease/ Organs Most affected:** Mucocutaneous Leishmaniasis – presents with severe disseminated lesions that restructures the face (“zombie character wearing clothes and belt of the Brazilian flag”)

LEISHMANIA (about 15 different species)

- **Disease/ Organs Most affected:** Cutaneous Leishmaniasis (oriental sore, etc) – ulcerating skin sore

LEISHMANIA DONOVONI

- **Disease/ Organs Most affected:** Visceral Leishmaniasis – presents with scattered black spots, aka the black fever or kala-azer (“Man in scene with black spots all over”); **other symptoms include fever, weakness, pancytopenia** (“pan of food that look like lysed RBC and platelets”), and **hepatosplenomegaly** (“cow with liver and spleen spots”)
- **Diagnosis:** amastigotes in macrophages in bone marrow, liver, and spleen
- **Treatment:** in addition to stibogluconate sodium, also amphotericin B (“frogs/ amphibians”)



Protozoan Apicomplexa: **PLASMODIUM SPECIES** “The Queens and Warlords of Plasmodium”

PLASMODIUM VIVAX AND OVALE (“Warlord with Ax and Ovale shield”)

- **Disease/ Organs Most affected:** Benign Tertian Malaria – presents with 48 hour, or every other day fever spikes (“Warlord’s pendulum swing’s ovals are alternating red and black for fever days”)
- **Diagnosis:** Blood stain and Giemsa stain to see parasites in RBCs (“blood smeared chest of gems”) – for *P. vivax* on blood smears, enlarged host cells and ameboid trophozoites are seen; for *P. ovale*, oval jagged, infected RBCs are seen
- **Liver Stage:** persistent hypnozoites are seen and can relapse (“warlord is using hypnosis and standing next to the cow with a liver-shaped spot”)
- **Treatment:** chloroquine PO₄ (“warlord next to African queen wearing colored garb”) then primaquine to eliminate the liver stage (“primal queen behind the color queen”)

PLASMODIUM MALARIAE (“warlord with ‘mal-odor’ symbols”)

- **Disease/ Organs Most affected:** Quartan or Malarial Malaria – 72 hour fever spikes, or fever is every 3 days (“tunic has 4 buttons with the first and 4th button red”); recrudescence, a reoccurrence of symptoms from low levels of organisms remaining in the red cells can occur
- **Diagnosis:** bar and band forms; rosette schizonts on blood smears
- **Treatment:** Chloroquine PO₄, no radical cure necessary

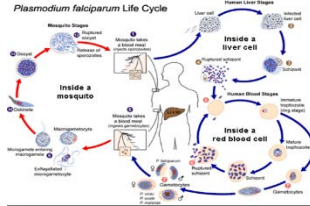
PLASMODIUM FALCIPARUM (“warlord wearing a ‘false’ mask”)

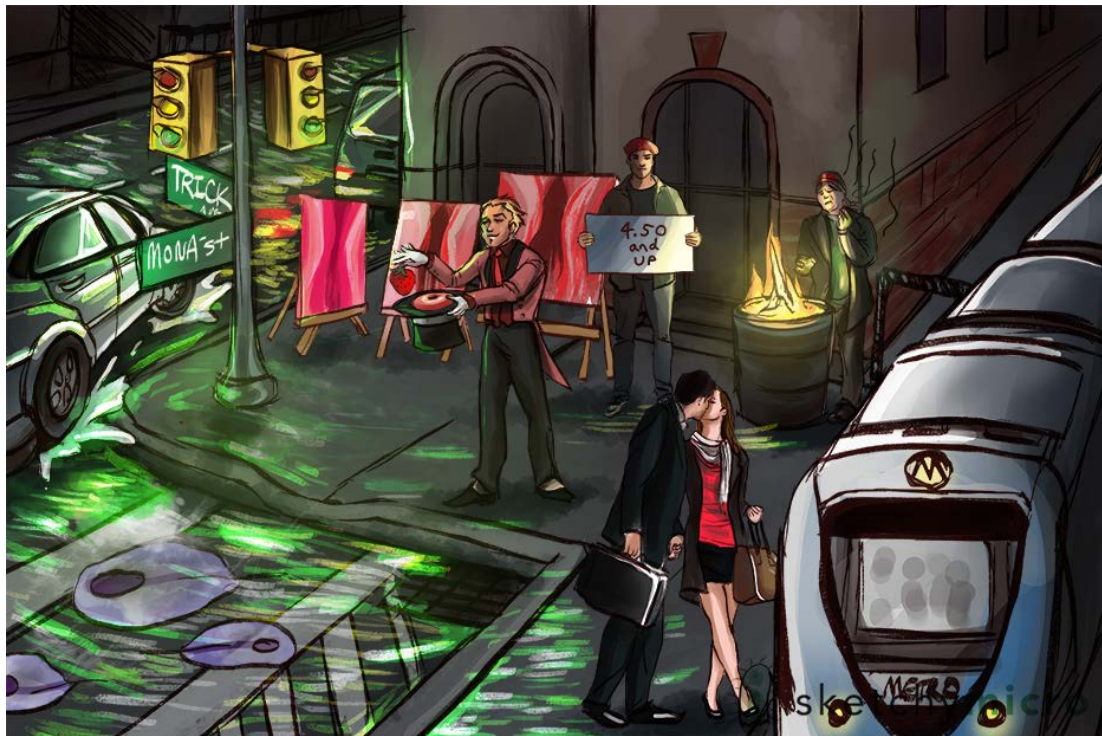
- **Disease/ Organs Most affected:** Malignant Tertian Malaria – presents with irregular fever spikes (“warlord’s hem is irregular”); causes cerebral malaria (“warlord is wearing a red headdress”); parasitized RBCs can also occlude vessels to the kidneys and lungs (“gold chest plates over lungs and intricate kidney-shaped belt”)
- **Diagnosis:** blood smear shows multiple ring forms (“one of the cow spots is ring-formed”) and crescent/banana-shaped gametes (“headdress with banana-shaped feathers; male and female signs branded on cow for gametes”)
- **Treatment:** Chloroquine resistance is a problem*** Use artemisins for severe *P. falciform* infections, which is often used with atovaquine and proguanil (“artist next to warlord painting ato-vampire queen”); sickle cell disease is protective against *P. falciparum* (“artist is holding up a sickle against warlord”)

Other Treatment Medications

- Mefloquine is a strong prophylaxis for travelers to chloroquine-resistant areas (“the ‘Me-Fly’ queen with many feathers sitting in a palanquin to show strength with travelers luggage and back pack on top”); atovaquine used with proguanil also great prophylactic agent and treatment (“ato-vampire queen sitting in similar palanquin with luggage”); IV artesunate (“artist way in the background comes only when needed”) is used for severe malarial infections; same with quinidine, but quinidine has side effects of cinchonism, including tinnitus (“dining queen in background with tin cans”) – both artesunate and quinidine are used IV (“ivy around the dining queen and the artist”)

Plasmodium Life Cycle: anopheles mosquitos carry the sporozoites in their saliva (“mosquito on red mushrooms that produce spores”); mosquito bites and allows sporozoites to migrate in human bloodstream to invade hepatocytes (“cow with liver spot”); once in liver cells, divide into schizont and rupture from the hepatocytes (exoerythrocytic) to invade red blood cells as merozoites and then mature into trophozoites and follow life cycle until RBCs lyse (erythrocytic) = “life cycle depicted in cow’s spots”

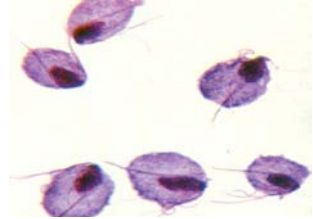




TRICHOMONAS VAGINALIS “Tricks for Money”

Protozoan Luminal Flagellate

- **Disease/ Organs Most affected:** Trichomoniasis: often asymptomatic, especially in males, but in females produces a frothy vaginal discharge that is yellow-green, has a fish-like odor, and causes burning and itching sensation (“ground is wet from rain with yellow-green shimmer from the traffic lights; woman with foul odor is scratching herself and wearing yellow-green around a burning fire”); **on examination, the cervicitis is described as “strawberry cervicitis”** (“the magician is pulling a strawberry out of his hat”)
- **Form/ Transmission:** Transmitted sexually (“couple kissing in the foreground”) as Trophozoites (“puddles on the ground resemble the trophozoites”)
- **Diagnosis:** Motile trophozoites in methylene blue wet mount; present with corkscrew motility (“moving car turning the corner is splashing water”)
- **Treatment:** Metronidazole (“Metro train in the scene!”)





METAZOAN: INTESTINAL NEMATODE ROUNDWORMS “Super Worms”

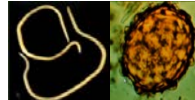
ENTEROBIUS VERMICULARIS (“Vermin Lady”)

- **Disease/ Organs Most affected:** Pinworms, perianal itching – female pin worms lay eggs at the anus (“Vermin lady climbing into a hole over egg-rocks”)
- **Form/ Transmission:** Eggs are transmitted fecal-orally person to person (“rats eating around the egg-rocks”)
- **Diagnosis:** Sticky swab of perianal area to collect ova (“Lady wearing long transparent tape-cape with egg-rocks”); ova have flattened side with larvae inside
- **Treatment:** pyrantel pamoate (“Lady fighting super hero, PAM!”); **mebendazole** (“Bendy bars along walls”)



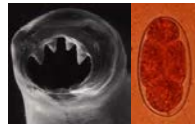
ASCARIS LUMBRICOIDES (“Lumbering Tree Man”) – most common helminth worldwide; largest roundworm

- **Disease/ Organs Most affected:** Ascariasis – eggs are ingested then larva migrate through the lungs, causing a pneumonitis (“spandex suit has a leaf on the chest”), but enter the GI tract where they mature; can obstruct the intestine or bile duct (“lumber man standing in front of a tunnel entrance blocked by rocks”)
- **Form/ Transmission:** Eggs are ingested, travel through blood, enter lungs then GI tract (“directionality super symbol on spandex”)
- **Diagnosis:** Bile stained, knobby eggs found in feces (“acorns in puddle around him”)
- **Treatment:** Mebendazole (“Bendy bars”); supportive therapy during pneumonitis; surgery for ectopic migrations



NECATOR AMERICANUS and ANCYLOSTOMA BRAZILIENSE/ CANINUM (“American Dude with ankle bracelets and neck chokers”)

- **Disease/ Organs Most affected:** Hookworm infection (“Dude using hookshot”) – bloodsucking leads to iron deficiency anemia (“iron hanging from hookshot”). Cutaneous larva migrans – intense skin itching from dog/cat hookworms.
- **Form/ Transmission:** Filariform larva penetrates intact skin of bare feet (“Dude wearing red boots”) but cannot mature in humans; travels from blood stream to lungs to GI tract (“directionality super symbol on spandex”)
- **Diagnosis:** Fecal larvae (up to 13 mm) and ova: oval, transparent with 2-8 stage visible inside (“grenades falling into brown water”); occult blood fecal may be present; eosinophilia found in labs (“Eos-sling shot boy with bi-lobed sling shot”)
- **Treatment:** Mebendazole (“bendy bars”) and iron therapy



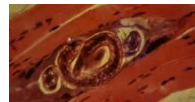
STRONGYLOIDES STERCORALIS (“Strong guy”)

- **Disease/ Organs Most affected:** Threadworm strongyloidiasis. Early stages presents with pneumonitis, abdominal pain, and diarrhea. Later, presents with malabsorption, ulcers, and bloody stools.
- **Form/ Transmission:** Filariform larva penetrates intact skin; travels blood stream, enters lungs and then GI tract (“directionality super symbol on spandex”); autoinfection leads to indefinite infections unless treated - larvae hatch from eggs laid in intestinal walls, repenetrate the wall, and enter the blood stream (“Strong guy kicking a whole in the wall with egg rubble falling through”)
- **Diagnosis:** larvae found in stool (“worms escaping from the kicked-in hole and landing in brown water”); serology
- **Treatment:** Thiabendazole (“bendy bars”) and Ivermectin (“think of river-mectin so a no-dumping sign placed”)



TRICHINELLA SPIRALIS (“Porky Trickster wearing a spiral suit”)

- **Disease/ Organs Most affected:** Trichinosis – larvae encyst in muscle cause pain. Clinical findings include fever, vomiting, and periorbital edema (“Porky sweating, vomiting, and wearing red sunglasses”). Larvae get into the blood stream to enter striated muscle (“red pipes on striated brick wall with larva-bombs on them”); causes inflammation of the muscle leading to myalgias (“explosion of striated brick wall”). Additionally, splinter hemorrhages and eosinophilia will be present.
- **Form/ Transmission:** Viable encysted larvae in meat are consumed; used to be mainly pork, now mostly wild game meat
- **Diagnosis:** Muscle biopsy and clinical findings; **Treatment:** Steroids for sever symptoms, mebendazole (“bendy bars”)



TRICHURIS TRICHIURA

- **Disease/ Organs Most affected:** Whipworm cecum, appendicitis, and rectal prolapse
- **Form/ Transmission:** Eggs ingested
- **Diagnosis:** Barrel-shaped eggs with bipolar plugs found in stool; **Treatment:** Albendazole





METAZOANS: TISSUE NEMATODES “Screamatores III: Return of the Flesh Eaters”

TOXOCARA CANIS OR CATI (“The Wolfman”)

- **Disease/ Organs Most affected:** Visceral Larva Migrans – larvae wander aimlessly until they die, causing inflammation wherever they go; i.e. Ocular Larva Migrans can lead to blindness (“wolfman sleeping with a sleep patch over his eyes”)
- **Form/ Transmission:** Eggs ingested from handling puppies and their feces (“a bag of dog poop hanging on his chair”) or from eating dirt in the yard
- **Diagnosis:** Clinical findings and serology, eosinophilia (“eosinophilic pebbles shot by Eos-boy with bi-lobed slingshot”)
- **Treatment:** Mebendazole (“the chair wolfman is sitting on has bent metal legs”); **self-limiting in most cases**

WUCHERIA BANCROFTI; BRUGIA MALAYI (“The Witch”)

- **Disease/ Organs Most affected:** Elephantiasis (“witch is wearing really large, wide pants”) – **presents with fever, lymphangitis, lymphadenitis – blocked flow to the lymphatics causes major lymphedema** (“witch’s clothing has ruffles on the collar and under armpits to represent LAD”); **also causes coughing as the microfilariae infiltrate the lungs** (“witch is coughing”)
- **Form/ Transmission:** Mosquito (“mosquitoes flying around the witch’s head”)
- **Diagnosis:** Microfilariae in the blood (“blood smear on witch’s hat”); **eosinophilia** (“eosinophilic pebbles shot by Eos-boy with bi-lobed slingshot”)
- **Treatment:** surgery, Ivermectin, and Diethylcarbamazine (“Witch is reading a Diet and Carb Magazine”)

LOA LOA (“The Swamp Creature”)

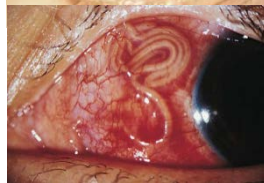
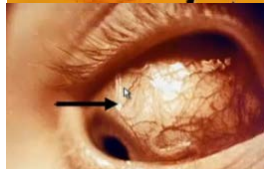
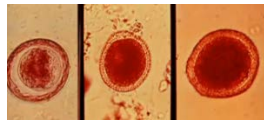
- **Disease/ Organs Most affected:** African Eye Worm (“worm is in swamp creature’s eye”); **Pruritus, angioedema described as calabar swellings** (“lumps all over swamp creature’s body”)
- **Form/ Transmission:** Chrysops mango flies (“flies flying around swamp creature’s head”)
- **Diagnosis:** microfilariae in blood (“blood across swamp creature’s face”); **eosinophilia** (“eosinophilic pebbles shot by Eos-boy with bi-lobed slingshot”)
- **Treatment:** surgical removal of worms; DEC (“also reading the Diet and Carb Magazine”)

ONCHOCERCA VOLVULUS (“The Evolved Fly”)

- **Disease/ Organs Most affected:** River Blindness (“the evolved fly covering his eyes with his human arm”); **produces an itchy “leopard” rash and hyper/ hypo-pigmented spots with onchodermatitis** (“red spots all over the evolved fly’s coat and pants”); **produces nodules filled with the worm**
- **Form/ Transmission:** Blackflies (“thus the evolved fly”)
- **Diagnosis:** Skin snips from calabar swellings under a microscope (“microscope behind the evolved fly scientist”)
- **Treatment:** surgical removal of the worms; DEC or Ivermectin (“think River-mectin, so ‘no dumping, drains to river’ sign”)

DRACUNCULUS MEDIENENSIS (“Dracula”)

- **Disease/ Organs Most affected:** Guinea Worm, Fiery Serpent – **creeping eruptions, ulcerations, and rash when worm gets under skin**
- **Form/ Transmission:** Drinking water with infected copepods, which are tiny crustaceans (“Dracula drinking from water cooler that has cups with the copepods drawn on them”)
- **Diagnosis:** Increased IgE, eosinophilia (“Eos-boy using a bi-lobed sling shot shooting eosinophilic granules”), **worm eruption from skin** (“Dracula’s long shoelaces are untied”)
- **Treatment:** Slow, cautious worm removal with a stick (“shoelaces are wrapped around leg of water cooler”); **albendazole helps**





CESTODE TAPEWORMS “Cestode County Carnival”

Metazoan Flat Worm (Platyhelminthes)

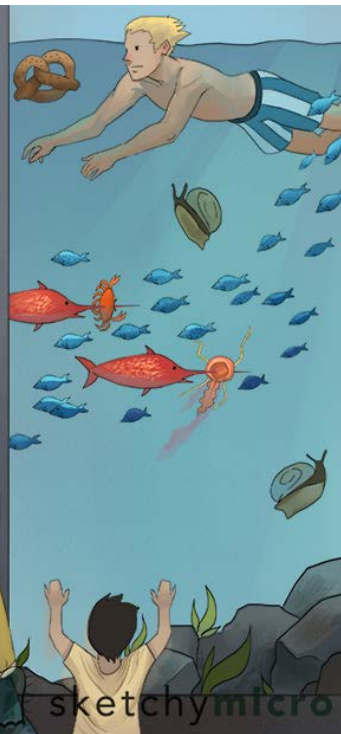
- **General Features:** consists of 3 basic portions – the head or scolex, a “neck” section, which produces the proglottids, and the segments or proglottids, which mature as they move away from the scolex (combination of neck and proglottids is called strobila). Hermaphroditic, with each proglottid developing both male and female reproductive organs, and mature eggs developing in the most distal proglottids. Adhere to mucosa via the scolex, which is knobby looking and has either suckers or a sucking groove. Have no GI tract; they absorb nutrients from the host’s GI tract. Have for the most part complex life cycles involving extraintestinal larval forms in intermediate hosts. When humans are the intermediate hosts, these infections are generally more serious than the intestinal infections with adult tapeworms.



CESTODE	FORM/ TRANSMISSION	DISEASE/ SX/ ORGANS	DIAGNOSIS	TREATMENT
TAENIA SAGINATA (“sagging tent”) IH: cattle (“cattle under tent”) DH: humans	Rare beef containing the eggs; cysticerci is ingested	Intestinal tapeworm/ small intestine Sx: asymptomatic or vague abdominal pains	Proglottids or eggs in feces	Praziquantel (“pretzel stand!”)
TAENIA SOLIUM (“tent with sun symbol”) IH: swine (“pig under tent”), rarely humans DH: humans in developing and Slavic countries	Water, vegetation, food contaminated with eggs (“eggs in the poop water”) Rare/ raw pork containing the cysticerci is ingested by humans	Cysticercosis: eggs become larva which develop further in the brain, eyes, heart, and lungs; brain infection = Neurocysticercosis which causes adult-onset epilepsy (“girl crashing into table of cheese with cheese hat for Swiss-cheese brain on CT”) Intestinal tapeworm; Sx same as for <i>Taenia saginata</i>	Biopsy Proglottids or eggs in feces	Praziquantel (“pretzel stand!”); albendazole for the neurocysticercosis (“muscle man AI bending a bar under Circus sign”) Praziquantel (“pretzel stand”)
DIPHYLOBOOTHRIUM LATUM (Fish tapeworm) (“man just ate fish and is running to the ‘bothrium = bathroom’”) IH: crustaceans, fish, rarely humans DH: humans, mammals, cool lake regions	Drinking pond water, copepods (crustaceans) carrying the larval forms or frog/ snake poultices Rare, raw picked fish containing sparganum	Sparganosis/ larvae penetrate intestinal wall and encyst Intestinal tapeworm up to 10 meters (“guy coming out of bathroom trailing long tp”); small intestine megaloblastic anemia from B12 deficiency (“B 12 fireworks with cobalt firework shooting up bursting into red”)	Biopsy Proglottids or eggs in feces (“squares of TP in poop water”)	Praziquantel (“guy eating pretzel”) or Niclosamide (“nickle coin box on bathroom”) Surgery; albendazole
ECHINOCOCCUS GRANULOSUS (“cocker spaniel dog winning the show”) IH: herbivores; rarely humans DH: carnivores in sheep-raising areas (“sheep dog in 2 nd place”)	Ingestion of eggs found in feces (“dog poop”)	Hydatid cyst disease = liver and lung where cysts containing blood capsules develop (“cocker spaniel has liver-shaped spot with ribbon representing cyst”); cyst rupture causes anaphylactic rxn and acute abdomen pain (“kid pulling ribbon off that crumbles apart representing rupture; kid is red and puffy”); egg—shelled calcifications found on liver CT (“golden cup for 1 st prize with cracked egg”)	Imaging, serology. Labs show eosinophilia (kid with bilobed slingshot)	Surgery; albendazole
ECHINOCOCCUS MULTILOCULARIS IH: rodents DH: canines and cats in northern areas	Ingestion of eggs	Alveolar Hydatid Cyst Disease	As above	Surgical Resection



SAN FRANSCHISTO OCEAN PARK



METAZOAN FLAT WORM: TREMATODE FLUKES “San Franschisto Ocean Park”

- **General Features:** leaf shaped worms which are generally flat and fleshy, are hermaphroditic except for *Schistosoma*, which are separate male and female; have complicated life cycles occurring in two or more hosts; have operculated eggs (except for *Shistosoma*), which contaminate water, perpetuating the life cycle, and which are also used to diagnose infections; the first intermediate hosts are snails (“snails all over this aquarium”)

➤ **Treatment:** praziquantel (“pretzals!”)

SCHISTOSOMA MANSONI (“statue of mer-Man”) **AND JAPONICUM** (“Japanese tourists”)

- **Disease/ Organs Most affected:** intestinal schistosomiasis
- **Reservoir Hosts:** cats, dogs, cattle
- **Acquisition:** contact with water and skin penetration, working in rice fields (“swimmer in the tank”)
- **Progression in Humans:** skin penetration (itching) → migrate against portal vein circulation (“two red fish swimming against the pool of blue fish seen through the port-hole; blue fish towards liver-shaped coral”) → mature in veins of mesentery → eggs cause granulomas in liver, causing hepatomegaly; symptoms can present as portal HTN (“crack in the port hole”), cirrhosis (“liver-shaped coral”), and jaundice (“man wearing yellow”).
- **Diagnosis:** *S. mansoni* ova have characteristic subterminal and lateral spine (“mer-Man and adjacent fish have dorsal fins”); *S. japonicum* ova are round and smooth (“like the Japanese sun”)

SCHISTOSOMA HAEMATOBIIUM

- **Disease/ Organs Most affected:** vesicular schistosomiasis
- **Reservoir Hosts:** primates
- **Acquisition:** contact with water; skin penetration (“swimmer”)
- **Progression in Humans:** skin penetration (itching) → mature in bladder veins causing hematuria (“swordfish piercing bladder-shaped jelly fish”); chronic infection has high association with bladder carcinoma in Egypt and Africa (“another swordfish is piercing a crab, symbol for cancer”)
- **Diagnosis:** ova have terminal spine (“swordfish”)

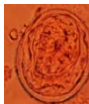
CLONORCHIS SINENSIS (“orca whale”)

- **Disease/ Organs Most affected:** Chinese Liver Fluke
- **Reservoir Hosts:** Dogs, cats, humans
- **Acquisition:** Raw fish ingestion
- **Progression in Humans:** organism mature and arise in the biliary system to cause biliary tract fibrosis that can lead to cholangiocarcinoma (“seaGull with dangling rope attached to crab cancer symbol”) or pigmented gallstones (“seagull sitting on black rocks”); causes serum-like sickness with vasculitis, rash, and fever
- **Diagnosis:** ova are operculated eggs – appear to have lids (“eggs with hats”)

PARAGONIMUS WESTERMANI (“penguins”)

- **Disease/ Organs Most affected:** Lung Fluke that causes chronic cough with bloody sputum (“black penguins with lung spots that are bloody”)
- **Reservoir Hosts:** Humans, cats, dogs, pigs
- **Acquisition:** raw crabs and crayfish (“one penguin feasting on crab legs”)
- **Progression in Humans:** inflammation in lungs cause blood-tinged sputum; may mimic pulmonary TB
- **Diagnosis:** ova are operculated eggs (“eggs with hats”)

Non-human schistosomes can cause swimmer’s itch; also acquired through contact with water with reservoir hosts in Birds. They penetrate the skin, producing dermatitis, without further development in humans; itching is most intense at 2-3 days. Treatment is with trimeprazine, calamine for the puritis, and sedatives for the itching.

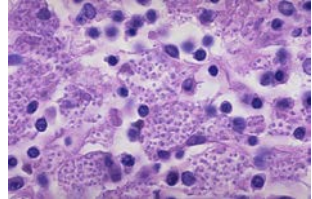


fungi



HISTOPLASMA CAPSULATUM “The Historian’s Cave”

- **Transmission:** Inhalation of bat or bird feces “Spelunker’s Disease” or chicken farmer (Coughing historian in a cave). **Endemic in the Ohio Mississippi river valley** (Map of US, if they give a region immediately think Fungal Infections)
- **Disease/ Organs Most affected:** Typically asymptomatic, but can cause lung granulomas (coughing historian) which can calcify (lung shaped wall cracks with calcifications near hilum) and look like TB (TB cactus in book). **Erythema nodosum** (Leg shaped stalactites with red dots). **Severe disease in immunocompromised individuals** (Immunocompromised cane) can have **disseminated disease that causes hepatosplenomegaly with calcifications** (Cow drawing with liver and spleen spots near cane).
- **Diagnosis:** Macrophage filled with small intracellular parasites in KOH prep (Macrophage cage and red and yellow puddles on ground) or rapid serum (red stalactite) or urine (yellow stalactite) **antigen test**. **Dimorphic fungi** (Dimorphic butterfly)
- **Treatment:** Fluconazole, Itraconazole, or Ketoconazole for local or mild infections (Pine cones) or **Amphotericin B** (amphibian drawing on stone and book) for disseminated infections.



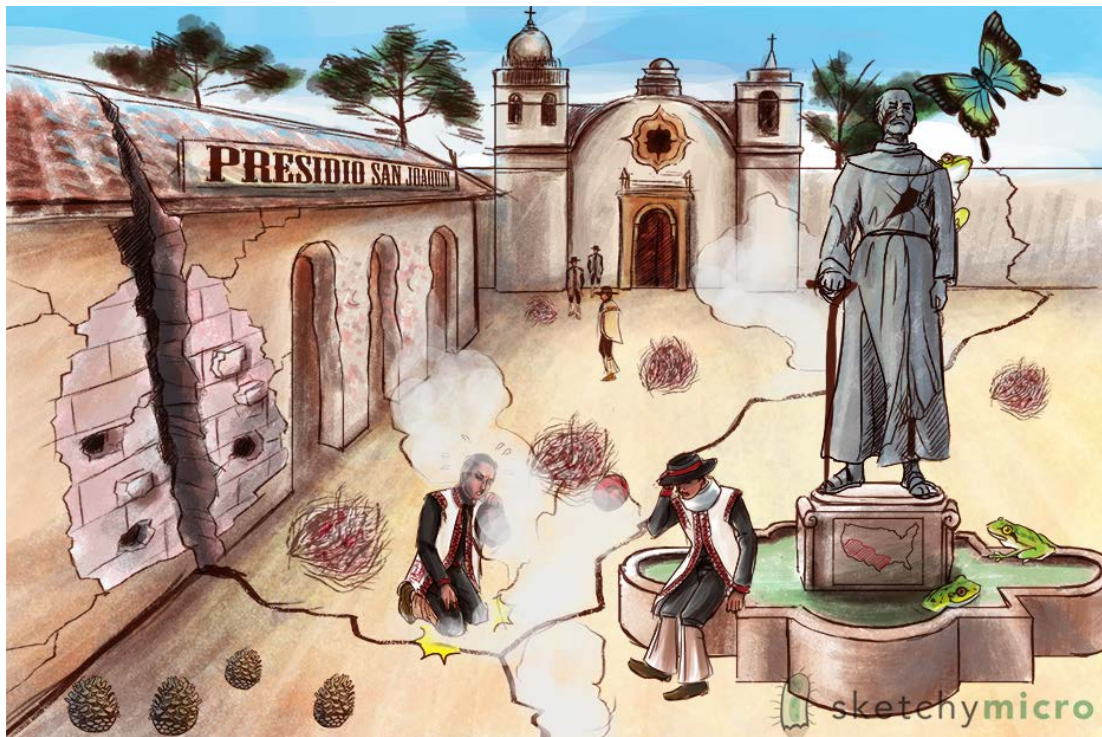
Other notes: For dimorphic fungi use the mnemonic “Body Heat Changes Shape” for Blastomyces, Histoplasma, Coccidioides, and Sporothrix. Also “Mold in the Cold, Yeast in the Heat (or beast)” to remember the forms of the dimorphic fungi will take in different environments.



BLASTOMYCOSIS DERMATITIDIS “The Blast of the Cannons”

- **Transmission:** Geographically found in the Ohio River Valley and Great Lakes region, but also along the East coast (Map and scene taken place during civil war, which covered a similar geographical distribution). **Found in dirt but can be aerosolized** (Soldier coughing).
- **Disease/ Organs Most affected:** Typically, a local lung infection (lung shaped cracks). In immune suppressed, it can go systemic (statue of General Lee with cane). **Systemic infection includes skin and bone lesions - osteomyelitis** (shrapnel on skin, chunk taken out of leg).
- **Diagnosis:** Dimorphic fungi (butterfly). KOH stain with broad-based budding (Cannon balls held by coughing soldier). Hazy alveolar infiltrate in lung X-ray with possible lesions or cavities (lung shaped cracks with smoking cannon balls). **Antigen testing of urine** (Yellow river).
- **Treatment:** Itraconazole for local infections (for local lung infections). **Amphotericin B** (amphibians around the statue that signifies systemic side effects) **for disseminated infections.**





COCCIDIOIDES IMMITIS “Presidio San Joaquin”

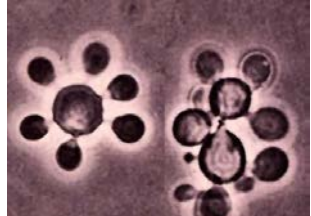
- **Transmission:** Found in the southwestern United States (Map). Inhaled spores in air spread by dust storms (clouds of dust). San Joaquin Valley fever (name of video). Earthquakes also kick up dust and can spread the spores (cracks in the ground and walls)
- **Disease/ Organs Most affected:** Valley Fever - usually asymptomatic in the healthy, but can present with self-limited acute pneumonia with arthralgia, fever, and sweating (soldier kneeling on ground coughing, red, and sweating with knee pain). Chest X-ray is usually unremarkable, however there may be cavities, nodules, or both (lung shaped wall cracks with missing bricks – cavities- and bricks pulled out – nodules). Erythema nodosum is another finding, which is even more classic here than in Histoplasma (leg shaped wall arches with red spots). In immunocompromised people (statue with cane), the skin and lungs are often infected (cracks and lesions on statue) and it can disseminate to the bone (rod exposed on leg). Can also cause meningitis (soldier leaning on statue holding head with neck brace).
- **Diagnosis:** KOH stain or culture. Serology can be checked for antibody titers (common theme so not show in video).
- **Description:** Dimorphic (butterfly). Mold in the cold, BUT it is a spherical endospore in the body (tumbleweeds with little circles within the big spheres). Spherical are larger than RBCs (RBC-looking red sombrero next to much larger tumbleweed).
- **Treatment:** For local infections use -conizoles (pinecones). Amphotericin B (amphibians around the statue that signifies systemic side effects) for disseminated infections.





PARACOCOCCIDIoidES BRASILIENSIS “*Piratas del Sur (Pirates of the South)*”

- **Transmission:** Distributed in Brazil and other parts of South America and is sometimes referred to as Brazilian Blastomycosis (South American map). Transmitted through respiratory droplets (spittle while coughing).
- **Disease/ Organs Most affected:** Lymphadenopathy that can be cervical, axillary, or inguinal (beads in hair going down neck). Can progress to lungs and cause granulomas (necklace). Mucosal ulcers in upper respiratory, especially in the mouth in the gums with ragged borders and small spots of hemorrhage (pirate’s nasty teeth).
- **Description:** Dimorphic. (Butterfly tattoo). Mold in the cold, yeast in the heat. Paracocci in yeast form that has multiple buds that radiate out from a central vacuole often described as looking like a captains wheel (wheel) that is much larger than a RBC (Red center of wheel).
- **Treatment:** Itraconazole for mild infections (pinecones hanging from ceiling) and amphotericin for severe infections (amphibian frogs around wheel).



Ristorante Italiano di Malassezia

VERSI DI
COLORE SAUCE



KOH

sketchy micro



MALASSEZIA FURFUR “Malassezia’s Italian Restaurant”

- **Transmission:** Part of normal skin flora and thrives under hot and moist conditions.
- **Populations at risk:** Immunocompromised, people who spend a lot of time in the sun, infants receiving TPN.
- **Disease/ Organs Most affected:** Pityriasis versicolor in healthy individuals



that causes non-itchy hypo- or hyper-pigmented patches (Light and dark sauce on chef’s back and chest) especially in individuals who spend a lot of time in the sun. Stays in the stratum corneum, the most superficial (Lasagna with top layer pulled off and corn – for corneum – on top). In the immunocompromised, it can be devastating but not high-yield. In neonates receiving total perineal nutrition (TPN) containing a lipid infusion through a catheter that can be contaminated with *Malassezia* (baby holding catheter-like spaghetti) and cause sepsis and thrombocytopenia. Adults can also have problems but usually less severe.

- **MOA:** Lipid degradation produces acid that damages melanocytes (broken bottle of olive oil).
- **Diagnosis:** Spaghetti and meatball appearance on KOH prep of skin scrapings (the dinner with KOH being sprinkled over).
- **Treatment:** Topical selenium sulfide aka. Selsun Blue (stained glass blue sun over doorway) which works by promoting shedding of the stratum corneum.

Note: Women in fur coat for Malassezia “Furfur”.





DERMAOPHYTES “*Tinea Tin Man*”



Three types of dermatophytes – Trichophyton, epidermophyton, and microsporum. (Three little munchkins with their letters on their chest. They are naked because they effect the skin).

- **Transmission:** Contact such as walking barefoot in locker rooms, skin to skin contact as in wrestling, or spread by animals (Toto the dog).
- **Population at risk:** Athletes (athletic headband)
- **Disease/ Organs Most affected:** The disease tinea aka ringworm are pruritic skin lesions (tin man with rings of rust scratching himself), and is mostly the same in all 3 dermatophytes.

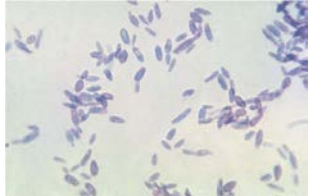
<i>Tinea capitis</i>	Scalp
<i>Tinea corporis</i>	Body
<i>Tinea cruris</i>	Groin (aka jock itch)
<i>Tinea pedis</i>	Foot (aka athletes foot)
<i>Onychomycosis</i>	Nail infection (Wizard of Oz biting nails)

- **Diagnosis:** History and physical. Confirmation by seeing hyphae with KOH prep of skin scrapings (munchkin holding KOH salt-shaker). Woods lamp can be used to diagnose microsporum by illuminating them (woodslamps in the trees)
- **Treatment:** Topical –azols (pinecones in trees). Onychomycosis often requires oral treatment with Terbinafine (Wizard wearing turbin). Severe infections can be treated with oral Griseofulvin (Wizard holding a can of grease) but this has GI side effects.



SPOROTHRIX SCHENCKII "*Shanked by a Rose*"

- **Transmission:** Scratches from rose thorns (the entire scene) which is why it is often called "**Rose Gardener's Disease**". Also found on tree bark, bushes, and plants (greenery in garden).



- **Disease/ Organs Most affected:** Local pustule at site and further nodules can develop along ascending lymphatics (vines with buds climbing walls and up her arms).



- **Description:** Dimorphic (butterfly). Branching hyphae that would be seen if grown at 25°C (Branching rose plants) and cigar shaped yeast (gardener smoking cigar).
- **Diagnosis:** Culture is the gold standard. Biopsy would show granulomas with histocytes, multinucleated giant cells and cigar shaped budding yeasts.
- **Treatment:** Itraconazole (Pinecones). Up until the 90's they used a saturated solution of potassium iodide (her pesticide pack) but this isn't used much anymore.



CANDIDA ALBICANS "*Candid Canadians*"

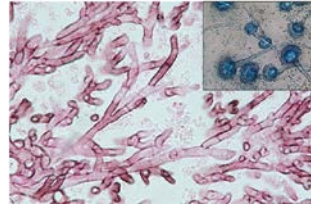


- **Transmission:** Normal flora of GI tract in 40% of population and only causes problems in immunocompromised individuals (man with cane). Most common cause of opportunistic mycosis.
- **Disease/ Organs Most affected:**
 - Cutaneous and systemic fungal infections. Diaper rash due to the warm moist environment (crying baby in red swing seat).
 - Oral candidiasis in people who use oral steroids (boy with inhaler and white snowy tongue) or immunocompromised (old man with white beard).
 - Candida esophagitis is an AIDS defining illness and cause white pseudo-membranes in the esophagus (esophagus slide with open mouthed animal and white patches in slide). Develop at CD4 < 100 (Sign that says Max 100 lbs)
 - Vaginal candidiasis (women taking snowball to the groin). Risk factors include oral contraceptives, diabetes, and antibiotics (bag fallen open with diabetes candy jar, prescription bottle and birth control pills on the ground). Antibiotics kill normal flora and allow candida to flourish, but candida does not change vaginal pH and cannot grow under 4 pH (sign: Playground open until 4 pH).
 - Endocarditis common seen in drug users as it can contaminate heroine. Tricuspid is most effected (tri-heart pyramids on top of slide)
- **Diagnosis:** In oral candidiasis, the white patches can be scraped off (adult shoveling snow) and the scrapings can be prepared with a KOH prep (KOH salt shaker next to shoveler).
- **Description:** Dimorphic, but mold in the heat, yeast in the cold - opposite (butterfly). Forms pseudo-hyphae and budding yeast at 20°C (greenery in foreground that look like pseudo-hyphae with snowballs to look like yeast, and thermometer next to is reading 20°C) and germ tubes-hyphae molds at 37°C (snow cone stand with name "37 flavors" with straws that look like a cell and germ tube formation). Catalase positive (cat by playground). People with chronic granulomatous disease are especially susceptible to Catalase + organisms.
- **Treatment:** Local or mild infections use -azoles (pinecones). Systemic and severe use Amphotericin B (frog toys). Oral or esophageal candidiasis use Nystatin (sign: Play Nyce). For disseminated for resistant candida use Capsogungin (winter cap on immunocompromised man).



ASPERGILLUS FUMIGATUS “Asparagus Farm”

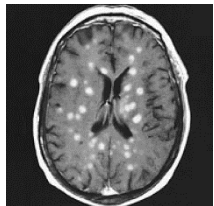
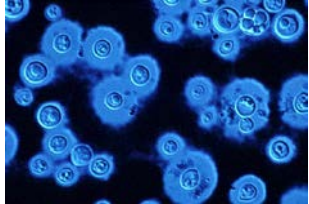
- **Transmission:** Conidiophores-fruiting bodies that sit at the top of a stalk-are released into the air and inhaled (Yellow flowers on peanut plant).
- **Disease/ Organs Most affected:**
 - **Aspergillus flavus** are associated with aflatoxins, as are peanuts and wheat crops (peanut plant in foreground, wheat field behind scarecrow) which are carcinogenic and can cause hepatocellular carcinoma (cow with liver-shaped spot).
 - **Allergic bronchopulmonary aspergillosis (ABPA on crop duster) type I hypersensitivity** that cause wheezing, fever, and migratory pulmonary infiltrate (red, sweating farmer running, or migrating with an inhaler). Patients will have increased IgE (written on the inhaler).
 - **Aspergillomas- fungus balls in the lungs.** People who already have cavities in their lungs, e.g. TB or klebsiella, are more likely to acquire aspergillomas (TB cactus). Aspergillomas are gravity dependent and fall to the bottom of the lungs on upright chest X-ray (peanuts in cavities at bottom of screen).
 - **Angioinvasive Aspergillosis affects immunocompromised** (right hand farmer with cane), specifically those with neutropenia from leukemia or lymphoma. Invades blood vessels and disseminates throughout body (sprinkler system). Causes fever and cough with hemoptysis (sweating farmer with bloody handkerchief). Kidney failure, endocarditis, and ring-enhancing brain lesions result from dissemination (scarecrow with straw patches in each of these areas). The ring-enhancing lesions are how you differentiate from TB. Can also invade paranasal sinus and cause necrosis around nose (black nose hole on scarecrow) – careful this also happens in Mucor.
- **Diagnosis: Biopsy**
- **Description:** Catalase positive (cat on scarecrow). Hyphae of aspergillus form hyphae with acute angles - $\geq 45^\circ$ - and septations (angle of peanut plant stems). Will likely need to distinguish from Mucor based on morphology. (You can also use the AS in aspergillus, A – acute and S – septate).
- **Treatment:** for less serious infections, -conozoles specifically voriconazole (pinecones and vortex with pinecones). Surgical debridement for aspergillomas in addition to medical treatment. For angioinvasive disease, Amphotericin B (amphibians by farmers).





CRYPTOCOCCUS NEOFORMANS "*Crypt for Cryptococcus*"

- **Transmission:** Normally found in soil and is within pigeon droppings which can be inhaled (pigeons with droppings all around, and archeologist coughing).
- **Populations at risk:** Mostly only affects immunocompromised people, e.g. HIV (mummy holding cane).
- **Disease/ Organs Most affected:**
 - Primarily in the lungs causing cough, dyspnea, and other serious lung infections (archeologist coughing).
 - **Meningitis – most common cause of fungal meningitis** (archeologist with neck brace). At best this will result in a very long recovery and brain damage. At worst, death. On imaging, soap bubble lesions will be seen (soap bubbles on mummy's head).
 - **Fever** (Archeologist is red faced and sweating).
- **Description:** Heavily encapsulated (large heavy sarcophagus). **Capsule contains repeating polysaccharide capsular antigens that are its main virulence factor** (repeating circles on left sarcophagus) **which make the capsule anti-phagocytic. Urease positive** (ammonia bottle)
- **Diagnosis (most high yield):** **Bronchopulmonary washings of lung tissue** (bubbles on mummy's chest). **Tissue samples can be stained with mucicarmine –red- or methanamine-silver- stains** (red and silver painted sarcophagus). **Lumbar puncture where CSF is stained with India ink and the organism will remain transparent**. **Yeast will be 5-10 µm with wide capsular halos** (vat of tar with light circles that have halos). **Latex agglutination test detects the repeating polysaccharide capsular antigen** (the cleaning archeologist has latex gloves on).
- **Treatment:** **Joint therapy with Amphotericin B** (amphibian drawings) **and flucytosine** (person playing flute) **followed by a maintenance therapy of fluconazole** (Pinecone drawing). Notice how the frog and flute are together followed by the pinecone.



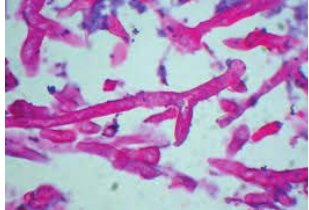
MU CAR AUTO SHOP

— RIDES 'R' US —



MUCORMYCOSIS “Mu Car Auto Shop”

2 types: *Mucor* (Mu Car Auto Shop) and *Rhizopus* (Rides ‘R ‘Us)



- **Transmission:** Spore inhalation (mechanic coughing).
- **Populations at risk:** Immunocompromised people, esp. with leukemia and neutropenia (man with cane). **Diabetics** (jar of candy).
- **Disease/ Organs Most affected:** Fungi proliferate in blood vessel walls (red jumper cables) where there is extra glucose and ketones – therefore diabetic ketoacidosis is the most common predisposing factor (sign: ketone auto parts). It then can penetrate the cribriform plate of the skull to enter the brain (oil pan with leaking holes to represent the cribriform plate). This results in necrosis rhino-cerebral mucor mycoses causing a black eschar on the face and frontal cortex abscesses (mechanic with oil on nose and running down face) **Very poor prognosis.**
- **Description:** *Rhizopus* is a bread mold (man holding baguettes). Wide angled branching (90° angles) and non-septated hyphae (tire iron that crosses at 90° and is solid, i.e. no septations). Contrast with aspergillus).
- **Treatment:** Surgical debridement. Amphotericin B (frog-looking car and FROGLVR license plate).



PNEUMOCYSTIS JIROVECI "PCP Ping Pong"

- **Transmission:** Respiratory transmission.
- **Populations at risk:** Healthy people are usually asymptomatic. Immunocompromised people, specifically AIDS patients (sign: AID for AIDS and player with cane). People become susceptible and require prophylactic treatment when CD4 < 200 (score 20 0).
- **Disease/ Organs Most affected:** Pneumocystis Pneumonia - Diffuse interstitial pneumonia. Non-productive cough, dyspnea, fever. No consolidations will be seen on X-Ray. If anything is seen at all, there will be a wispy, ground-glass appearance (cracked glass ping pong tables and crushed ping pong balls).
- **Description:** Oval shaped yeast (oval shaped ping pong balls).
- **Diagnosis:** Broncho-alveolar lavage (player drinking water with BAL on water bottle). Methamine silver stain of tissue will reveal disc shaped yeast (silver discs in center of tables).
- **Treatment:** Prophylaxis and treatment is Bactrim (older player doing a backhand) – **combo of trimethoprim and sulfamethoxazole** (jar of ping pong balls that look like eggs for sulfa drugs). If there is a sulfa allergy, you can use pentamidine (pentagon shaped paddles).

