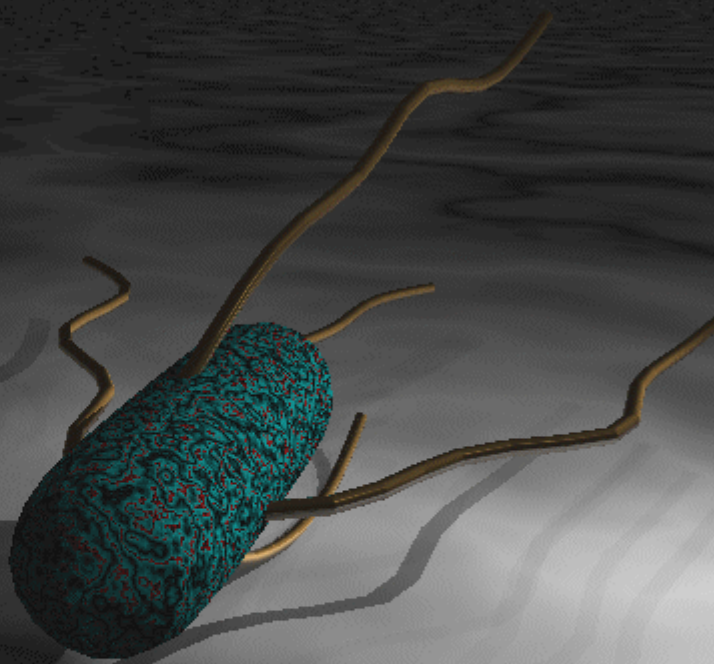


UNREGISTERED

Bacteria

Gram Positive Cocci
Gram Positive Rods
Gram Negative Cocci
Gram Negative Rods
Mycobacteria
Spirochetes
Mycoplasmas
Actinomycetes
Chlamydia
Rickettsiae

Main Menu

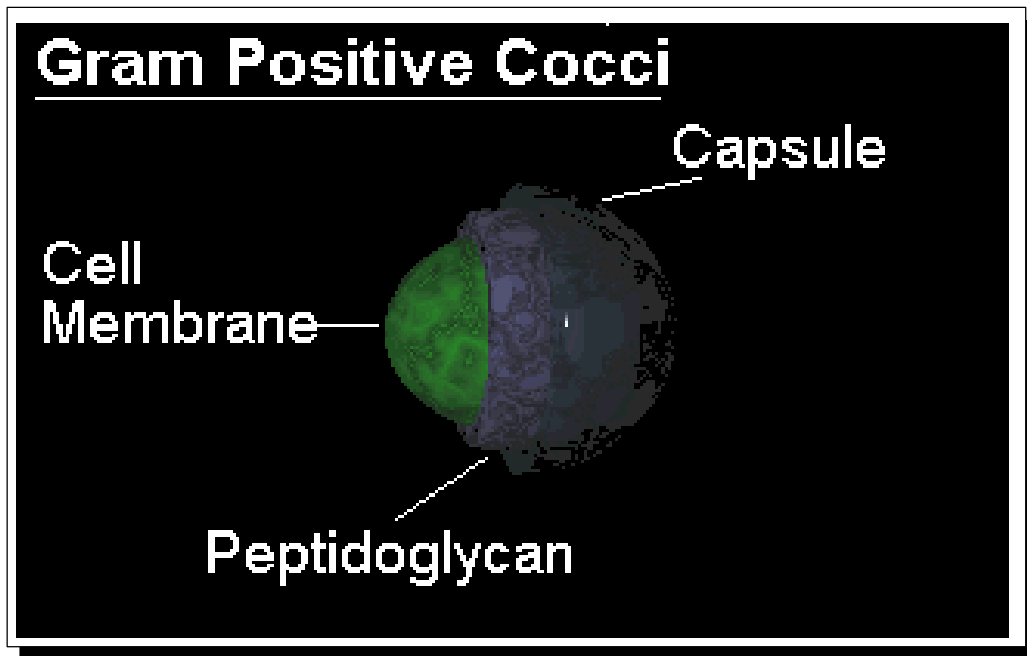


Text and Illustrations are Copyright 1998 by the Third Wave Corporation

Version 2.0 Spring 1998

UNREGISTERED

GRAM-POSITIVE COCCI

*Staphylococcus aureus*

Characteristics	Gram-positive cocci found in clusters. Causes abscesses, endocarditis, gastroenteritis, and toxic shock syndrome.
Habitat & Transmission	Habitat is the nose and human skin, transmitted by hands.
Diagnosis	Gram-positive and coagulase positive. Forms yellow/gold colonies on blood agar. Beta hemolytic at 4°C. Ferments mannitol.
Treatment	Penicillinase resistant penicillin. Vancomycin used for methicillin resistant <i>S. aureus</i> (MRSA). Resistance to Vancomycin and many other drugs is reported. Handwashing can reduce the spread of <i>S. aureus</i> .
Virulence Factors	Receptors for fibrinogen, laminin, and fibronectin mediate attachment to host tissues. Protein A binds to the Fc portion of IgG. Some strains produce a capsule that forms a biofilm on artificial surfaces. Produces coagulase, lipase, and several exotoxins. The exotoxins include cytolytic (Alpha Toxin), sphingomyelinase (Beta toxin), and a peptide with detergent properties (Delta toxin). Enterotoxins and Toxic Shock Syndrome Toxin-1 are T-cell superantigens, causing massive release of IL-2 and other cytokines. Exfoliative toxin breaks down the granular layer of the epidermis to form blisters. Peptidoglycan and teichoic acids can activate the alternative complement cascade to cause intravascular coagulation. Catalase provides protection against reactive oxygen species (ROS).

Staphylococcus epidermidis

Characteristics	Gram positive cocci in clusters that cause wound infections, bacteremia, subacute endocarditis.
Habitat & Transmission	Habitat is the human skin. Introduced into bloodstream by trauma or indwelling catheters.
Diagnosis	Gram positive, catalase positive, coagulase negative, non-mannitol fermenting, and urease negative.
Treatment	Penicillinase resistant penicillin or vancomycin. Antibiotic resistance is increasing.
Virulence Factors	Surface glycoproteins promote adherence to fibronectin. Some strains produce a capsule that forms a biofilm on artificial surfaces. Peptidoglycan and teichoic acids can activate the alternative complement cascade to cause intravascular coagulation. Catalase provides protection against reactive oxygen species (ROS).

Staphylococcus saprophyticus

Characteristics	Gram positive cocci in clusters. Common agent of urinary tract infections.
Habitat & Transmission	Normal vaginal flora. Trauma predisposes to adherence.
Diagnosis	Gram positive, catalase positive, coagulase negative, non-mannitol fermenting, and urease positive.
Treatment	Penicillin G.
Virulence Factors	Adheres to transitional epithelium. Urease reduces local pH and induces the formation of struvite stones. Catalase provides protection against reactive oxygen species (ROS).

Streptococcus agalactiae ('Group B strep')

Characteristics	Gram positive cocci that grow in chains. Common cause of neonatal sepsis and meningitis.
Habitat & Transmission	Normal vaginal flora.
Diagnosis	Gram positive, Beta-hemolytic, CAMP test positive, catalase negative, bacitracin resistant, and can hydrolyze hippurate. Antisera to cell wall polysaccharides are used to determine serogroup.
Treatment	Penicillin G or Ampicillin. Ampicillin can be given to culture-positive pregnant women before delivery.
Virulence Factors	Type III capsular antigen is a virulence factor for meningitis.

Streptococcus faecalis ('Enterococcus', 'Group D strep')

Characteristics	Gram positive cocci that grow in chains. Cause urinary tract infections, endocarditis, and sepsis.
Habitat & Transmission	Habitat is the human digestive tract. Can colonize the vagina.
Diagnosis	Gram positive, catalase negative, variable (alpha or beta or non) hemolytic, grows in 6.5% NaCl, and hydrolyzes esculin in the presence of 40% bile.
Treatment	Penicillin or ampicillin plus an aminoglycoside. Antibiotic resistance is increasing.
Virulence Factors	Cell wall has lipoteichoic acid which causes gram variable appearance in older cultures.

Streptococcus pneumoniae ('Pneumococcus')

Characteristics	Gram positive, lancet-shaped cocci found in pairs (diplococci). Causes pneumonia, meningitis, sinusitis, and otitis media.
Habitat & Transmission	Habitat is the human upper respiratory tract. Transmitted via respiratory droplets.
Diagnosis	Gram positive, alpha-hemolytic. Unable to grow in the presence of bile or optochin. Serotype specific antisera causes capsular swelling (Quellung reaction). Latex agglutination test can be used for rapid diagnosis.
Treatment	Penicillin G or cefotaxime or ceftriaxone. Antibiotic resistance is increasing. A polysaccharide vaccine for the 23 most common serotypes is available.
Virulence Factors	Antiphagocytic capsule. Older colonies release amidase which causes autolysis. Autolysis releases Pneumolysin-O which is a cytotoxin and anti-PNM protein. Complement deficiencies and asplenia predispose to disseminated disease.

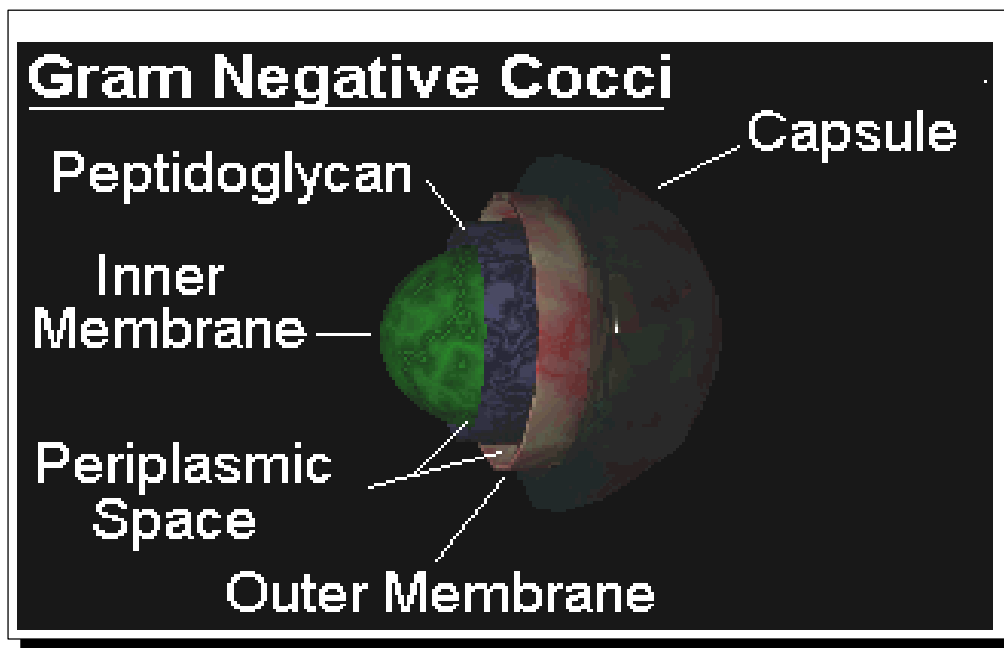
Streptococcus pyogenes ('Group A Strep')

Characteristics	Gram positive cocci that grow in chains. Causes pharyngitis, cellulitis, rheumatic fever, and post-streptococcal glomerulonephritis.
Habitat & Transmission	Habitat is human pharynx and skin. Transmitted via respiratory droplets.
Diagnosis	Gram positive, Beta-hemolytic, catalase negative, and Bacitracin sensitive. DNase positive. Serology used to determine serotype (antiserum directed against cell wall C polysaccharide). Antistreptolysin O titer used to diagnose prior infection if rheumatic fever is suspected.
Treatment	Penicillin G.
Virulence Factors	Virulence factors include hyaluronidase, a phage encoded erythrogenic toxin (scarlet fever toxin), antiphagocytic M protein, a protein which degrades complement protein C5a, several hemolysins, neuraminidase, IgG protease, and IgA protease. Necrotizing fasciitis ('flesh eating bacterial infection') is caused by strains that produce large amounts of hyaluronidase production and invade tissues. Rheumatic fever caused by cross reaction between anti-Streptococcal antibodies and host tissues (heart and joint). Immune complex deposition causes post-streptococcal glomerulonephritis.

Viridans Group Streptococci (S. mutans & S. sanguis)

Characteristics	Gram positive cocci that grow in chains. Cause endocarditis, human bite wound infections.
Habitat & Transmission	Habitat is the human oral cavity and pharynx. Enters bloodstream during dental procedures, or other oral trauma.
Diagnosis	Gram positive, catalase negative, alpha-hemolytic, and grows in the presence of bile and optochin.
Treatment	Penicillin G with an aminoglycoside. Antibiotic resistance is increasing. Antibiotics should be administered to patients with damaged or prosthetic heart valves before dental/surgical procedures.
Virulence Factors	Adheres to damaged heart valves, forming vegetative lesions that are relatively impermeable to host immune defenses.

GRAM-NEGATIVE COCCI

*Moraxella catarrhalis*

Characteristics	Gram negative diplococci. Causes sinusitis, bronchitis, otitis media, and pneumonia.
Habitat & Transmission	Habitat is the human pharynx. Transmitted by saliva.
Diagnosis	Gram negative cocci.
Treatment	Trimethoprim-Sulfamethoxazole. Most isolates produce beta lactamase, making them resistant to penicillins.
Virulence Factors	High mutation rate in outer membrane protein genes (OMP) prevents the development of long-term immunity to <i>M. catarrhalis</i> .

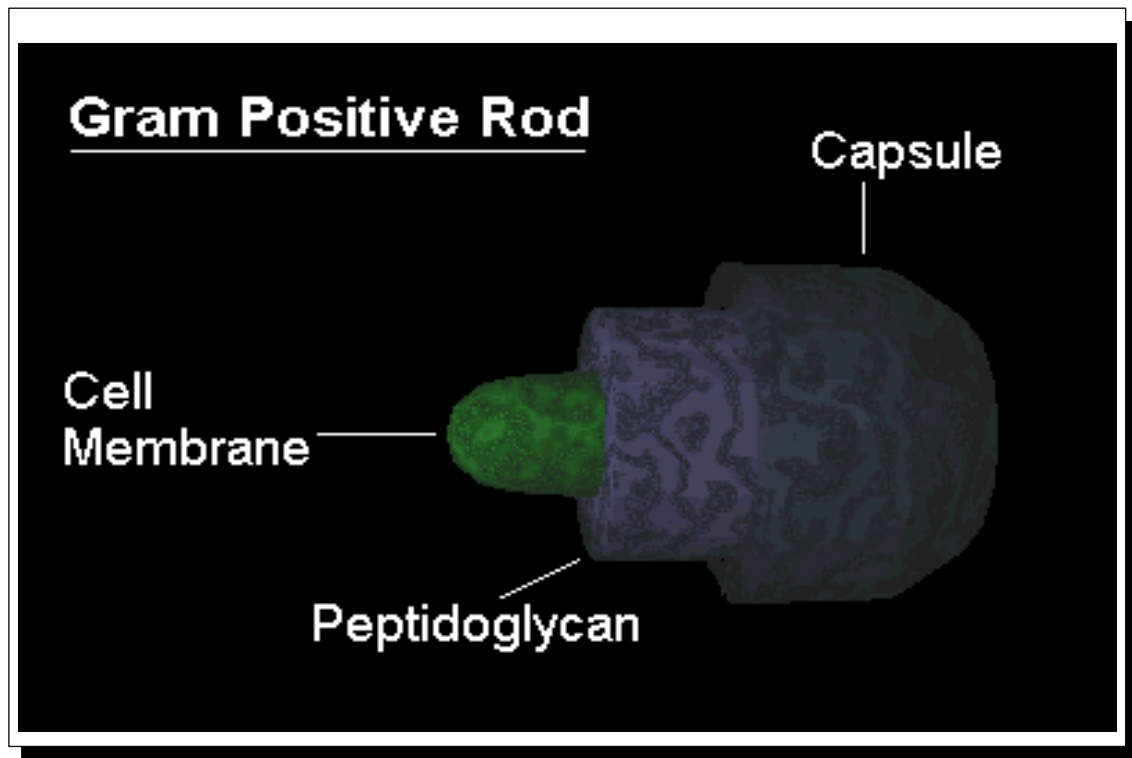
Neisseria gonorrhoeae ('Gonococcus')

Characteristics	Gram negative 'kidney bean' shaped diplococci. Causes gonorrhea, pelvic inflammatory disease, and neonatal conjunctivitis.
Habitat & Transmission	Habitat is the human genital tract. Transmitted by sexual contact or during vaginal delivery.
Diagnosis	Gram negative; oxidase positive on Thayer-Martin medium; and unable to ferment maltose.
Treatment	Ceftriaxone or spectinomycin. Most isolates are resistant to penicillin and other drugs. Silver nitrate or erythromycin ointment used to prevent neonatal conjunctivitis.
Virulence Factors	Organism uses pili to attach to mucous membranes, invades the membrane, and releases endotoxin. Can survive within PMN's. IgA protease and pili phase variation inhibits humoral immunity. Peptidoglycan stimulates host production of TNF-alpha. Lipooligosaccharide induces host immune cells to produce TNF-alpha. Peptidoglycan fragments are toxic to mucosal cells. Some strains produce proteases and phospholipases. Complement deficiencies and asplenia predispose to disseminated disease.

Neisseria meningitidis ('Meningococcus')

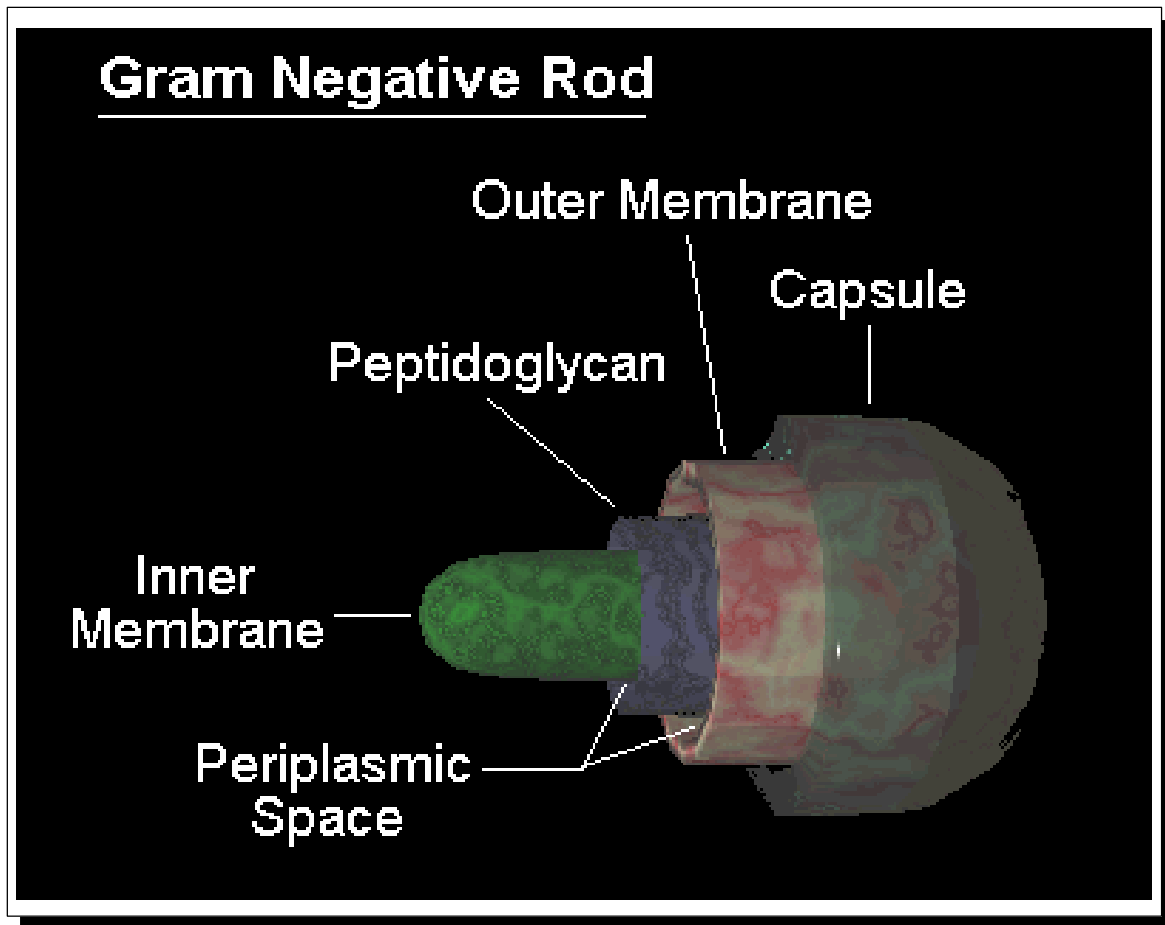
Characteristics	Gram negative encapsulated 'kidney bean' shaped diplococci. Causes meningitis and meningococemia.
Habitat & Transmission	Habitat is the human upper respiratory tract; transmission is via respiratory droplets.
Diagnosis	Gram negative, oxidase positive on chocolate agar, and ferments maltose.
Treatment	Penicillin G. High levels of resistance to sulfonamides are found. A polysaccharide vaccine for strains A, C, Y, and W-135 is available. Close contacts are given rifampin for prophylaxis.
Virulence Factors	Colonizes the respiratory tract and disseminates in the bloodstream. Meningial colonization is common. Endotoxin causes septic shock. The capsule is antiphagocytic and can disrupt the formation of the complement membrane attack complex (MAC). An IgA protease inhibits humoral immunity. Lipooligosaccharides (LOS) induce host immune cells to release TNF-alpha, IL-1, and IL-6. Complement deficiencies and asplenia predispose to disseminated disease.

GRAM-POSITIVE RODS



Arachnia propinica
Bacillus anthracis
Bacillus cereus
Bifidobacterium eriksonii
Clostridium botulinum
Clostridium difficile
Clostridium perfringens
Clostridium tetani
Corynebacterium diphtheriae
Listeria monocytogenes

GRAM-NEGATIVE RODS

*Achromobacter*

Characteristics	Gram negative coccobacillary rods that causes sepsis, pneumonia, and urinary tract infections.
Habitat & Transmission	Habitat is fresh water.
Diagnosis	Gram negative rod. Biochemical tests used for identification.
Treatment	Trimethoprim- sulfamethoxazole.
Virulence Factors	No toxins or virulence factors known.

Acinetobacter calcoaceticus

Characteristics	Gram negative coccobacillary rods that cause sepsis, pneumonia, and urinary tract infections.
Habitat & Transmission	Habitat is fresh water and soil. Transmission is via respiratory droplets or direct inoculation.
Diagnosis	Gram negative rod. Biochemical tests used for identification.
Treatment	Imipenem. Antibiotic resistance is increasing.
Virulence Factors	No toxins or virulence factors known.

Actinobacillus actinomycetemcomitans

Characteristics	Gram negative coccobacillary rods that causes sepsis and endocarditis.
Habitat & Transmission	Habitat is human upper respiratory tract. Transmission is via respiratory droplets.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Trimethoprim- sulfamethoxazole.
Virulence Factors	No toxins or virulence factors known.

Aeromonas hydrophila

Characteristics	Gram negative rods that causes wound infections and diarrhea.
Habitat & Transmission	Habitat is fresh water, soil, and feces. Transmission is by direct contact.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Trimethoprim- sulfamethoxazole.
Virulence Factors	No toxins or virulence factors known.

Alcaligenes faecalis

Characteristics	Gram negative coccobacillary rods that causes sepsis and pneumonia.
Habitat & Transmission	Habitat is fresh water and soil. Transmission is via respiratory droplets and direct inoculation.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Penicillin G.
Virulence Factors	No toxins or virulence factors known.

Arizona hinshawii

Characteristics	Gram negative rods that cause enterocolitis.
Habitat & Transmission	Habitat is feces of domestic animals. Transmission is via fecal oral route or by contaminated food (eggs).
Diagnosis	Gram negative rod that ferments lactose. Biochemical tests.
Treatment	Ceftriaxone.
Virulence Factors	No toxins or virulence factors known.

Bacteroides fragilis

Characteristics	Gram negative rod that causes abdominal abscesses, peritonitis, and sepsis.
Habitat & Transmission	Habitat is the human large intestine. Transmission is by traumatic disruption of the bowel wall.
Diagnosis	Gram negative, catalase positive, and anaerobic. Gas chromatography used to confirm identity.
Treatment	Metronidazole, clindamycin, or cefoxitin plus surgical drainage of abscesses. Antibiotic resistance is an increasing problem. The risk of infection can be reduced by preoperative antibiotics.
Virulence Factors	<i>B. fragilis</i> endotoxin is much less potent than typical endotoxin, causing fever and shock. Capsule is antiphagocytic.

Bartonella henselae

Characteristics	Gram negative rods that cause bacillary angiomatosis and cat scratch fever.
Habitat & Transmission	Habitat is the oral flora of cats. Transmission is via direct inoculation.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Ciprofloxacin.
Virulence Factors	No toxins or virulence factors known.

Bartonella quintana

Characteristics	Gram negative rods that cause trench fever.
Habitat & Transmission	Habitat is humans and other mammals. Transmission is by body louse.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	An Erythromycin.
Virulence Factors	No toxins or virulence factors known.

Bordetella pertussis

Characteristics	Small gram negative rods that cause Whooping cough (pertussis).
Habitat & Transmission	Habitat is the human respiratory tract. Transmission is via respiratory droplets.
Diagnosis	Gram negative and grows on Bordet-Gengou agar. Agglutination reactions used to identify serotype.
Treatment	An erythromycin. Two vaccines are available : a killed whole cell vaccine and an acellular vaccine. The acellular vaccine has fewer side effects. The pertussis vaccine is the 'P' in the DPT vaccine.
Virulence Factors	Pertussis toxin activates adenylate cyclase by ADP-ribosylation. An extracellular adenylate cyclase is also produced. Filamentous Hemagglutinin allows organism to attach to cilia and MAC-1 integrins. Peptidoglycan fragments are competitive inhibitors of 5-hydroxytryptamine (serotonin).

Brucella species (B. abortus, B. suis, B. melitensis)

Characteristics	Small gram negative rods that cause brucellosis.
Habitat & Transmission	Habitat is livestock. Transmission is via unpasteurized milk products or contact with an infected animal.
Diagnosis	Gram negative, catalase positive, and oxidase positive. Grows on Brucella agar which contains erythritol.
Treatment	A Tetracycline plus Spectinomycin or an aminoglycoside. Antibiotic resistance is increasing. Pasteurization of milk and vaccination of cattle reduces the risk of transmission.
Virulence Factors	Organism localizes inside reticuloendothelial cells and survives within macrophages. Endotoxin causes an inflammatory response.

Calymmatobacterium granulomatis

Characteristics	Gram negative rods that cause granuloma inguinale.
Habitat & Transmission	Habitat is humans. Transmission is by sexual contact.
Diagnosis	Gram negative rod that forms Donovan bodies within macrophages.
Treatment	A Tetracycline.
Virulence Factors	No toxins or virulence factors known.

Campylobacter jejuni

Characteristics	Gram negative comma shaped rods that cause enterocolitis
Habitat & Transmission	Habitat is human and animal GI tracts. Transmission is by the fecal-oral route.
Diagnosis	Gram negative, grows on Skirrow's or CAMPY agar, and grows at 42°C in a high-CO ₂ atmosphere.
Treatment	Supportive care. A Flouroquinolone or an Erythromycin given for severe cases. Antibiotic resistance is increasing. Can be prevented by public health measures (clean water and sewage disposal).
Virulence Factors	Invades mucosa of colon, lamina propria, and regional lymph nodes to cause inflammation. Releases cytotoxin and cAMP stimulating enterotoxin.

Capnocytophaga gingivalis

Characteristics	Gram negative fusiform rods that cause periodontal disease and sepsis.
Habitat & Transmission	Habitat is human oral cavity. Enters bloodstream after oral trauma.
Diagnosis	Gram negative fusiform rod. Biochemical tests.
Treatment	Ampicillin.
Virulence Factors	No toxins or virulence factors known.

Cardiobacterium hominis

Characteristics	Gram negative rod that causes endocarditis and sepsis.
Habitat & Transmission	Habitat is human colon. Trauma releases organism into bloodstream.
Diagnosis	Gram negative rod with pleomorphic staining. Biochemical tests.
Treatment	Metronidazole.
Virulence Factors	No toxins or virulence factors known.

Chromobacterium violaceum

Characteristics	Gram negative rod that causes wound infections.
Habitat & Transmission	Habitat is soil and water. Transmission is by direct inoculation.
Diagnosis	Gram negative rod that produces a violet pigment. Biochemical tests.
Treatment	Tetracycline.
Virulence Factors	No toxins or virulence factors known.

Citrobacter

Characteristics	Gram negative rods that cause sepsis.
Habitat & Transmission	Habitat is human colon. Enters bloodstream after GI trauma.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Metronidazole.
Virulence Factors	No toxins or virulence factors known.

Edwardsiella

Characteristics	Gram negative rods that cause sepsis, enterocolitis, and wound infections.
Habitat & Transmission	Habitat is human colon, water, and soil. Transmission is via fecal oral route or entry into bloodstream after GI trauma.
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Imipenem.
Virulence Factors	No toxins or virulence factors known.

Eikenella corrodens

Characteristics	Gram negative rods that cause sepsis and abscesses.
Habitat & Transmission	Habitat is human oral cavity. Enters bloodstream after oral trauma (often by human bite).
Diagnosis	Gram negative rod. Biochemical tests.
Treatment	Ampicillin. Antibiotic resistance is reported.
Virulence Factors	No toxins or virulence factors known.

Escherichia coli

Characteristics	Gram negative rods that cause sepsis, urinary tract infections, and gastroenteritis.
Habitat & Transmission	Habitat is the human GI tract and vagina. Transmitted during intercourse, vaginal delivery, or by the fecal-oral route.
Diagnosis	Gram negative, facultative, ferments lactose on EMB and MacConkey's agar, green colonies on EMB agar, and TSI tube shows acid slant/acid butt with gas production. Serotyped on the basis of O and H antigens.
Treatment	Third generation cephalosporins are used for sepsis and meningitis. Ampicillin and sulfonamides are used for urinary tract infections. Antibiotic resistance is common. Rate of infection can be limited by public health measures (clean water, sewage disposal).
Pathogenesis	Endotoxin causes septic shock and pilli mediate tissue attachment. Heat-labile (LT) toxin ADP-ribosylates adenylate cyclase to cause increased excretion of Cl ⁻ and water into the intestinal lumen. Heat stable (ST) toxin also causes diarrhea by an unknown mechanism. Verotoxin is produced by some strains (O157:H7) and causes bloody diarrhea by removing adenine from the 28S rRNA.

Francisella tularensis

Characteristics	Small gram negative rods that cause tularemia.
Habitat & Transmission	Habitat is wild animals (rabbits, deer, and rodents). Transmission is by tick bite, respiratory droplets, and contact with an infected animal.
Diagnosis	Culture usually not done because of risk to lab personnel, but will grow slowly on cystine agar. Diagnosis is made by serology.
Treatment	Streptomycin. Antibiotic resistance is increasing. An live organism vaccine is available.
Virulence Factors	Organism localizes inside reticuloendothelial cells and releases endotoxin.

Haemophilus ducreyi

Characteristics	Gram negative rods that causes chancroid.
Habitat & Transmission	Habitat is humans. Transmitted by sexual contact.
Diagnosis	Gram negative rod that grows on chocolate agar.
Treatment	Erythromycin or azithromycin or Ceftriaxone. Antibiotic resistance is increasing.
Virulence Factors	No toxins or virulence factors known.

Haemophilus influenzae

Characteristics	Gram negative coccobacillary rods that cause meningitis, otitis media, and pneumonia.
Habitat & Transmission	Habitat is upper respiratory tract. Transmission is via respiratory droplets.
Diagnosis	Gram negative and growth requires factors X and V. Serotype determined by immunological methods. Grows as satellite colonies around <i>S. aureus</i> colonies.
Treatment	Ceftriaxone. Rifampin can prevent meningitis in exposed individuals. Antibiotic resistance is increasing. A vaccine against the type B capsule is available.
Virulence Factors	Polyribitol capsule is required for virulence, and type B capsule is the most virulent. The capsules are antiphagocytic. Fimbriae and other proteins mediate attachment to upper respiratory tract. IgA protease and an inhibitor of ciliary beating are released. LPS is a leukocyte chemoattractant. Cell wall peptidoglycan can disrupt vascular endothelium and compromise the blood brain barrier. Complement deficiencies and asplenia predispose to disseminated disease.

Helicobacter pylori

Characteristics	Gram negative curved rods associated with peptic ulcers.
Habitat & Transmission	Habitat is the human stomach. Transmission is ingestion of bacteria.
Diagnosis	Gram negative, catalase positive, non-lactose fermenting, and urease positive. An elevated anti- <i>Helicobacter</i> antibody titer is diagnostic. Urease breath test is also diagnostic of infection.
Treatment	Amoxicillin, metronidazole, and bismuth. Antibiotic resistance is increasing.
Virulence Factors	Urease produces ammonia which directly injures the gastric mucosa.

Klebsiella pneumoniae

Characteristics	Encapsulated gram negative rods that cause urinary tract infections, pneumonia, and sepsis.
Habitat & Transmission	Habitat is the human respiratory tract and GI tract. Transmission is by respiratory droplets and the fecal-oral route.
Diagnosis	Gram negative, encapsulated, and lactose fermenting on MacConkey's agar.
Treatment	Third generation Cephalosporins with or without an aminoglycoside. Antibiotic resistance is a growing problem.
Virulence Factors	Endotoxin causes fever and shock. Antiphagocytic capsule.

Legionella pneumophila

Characteristics	Gram negative rod that causes Legionnaires' disease.
Habitat & Transmission	Habitat is warm fresh water (may live inside amoeba). Transmission is via respiratory droplets.
Diagnosis	Deterle Silver stain or fluorescent antibody stain to visualize organism (does not Gram stain!). Grows on charcoal yeast extract agar that is supplemented with iron and cysteine. Diagnosis confirmed by serology. Catalase positive.
Treatment	Erythromycin with or without rifampin.
Pathogenesis	Block respiratory burst and phagosome/lysosome fusion after phagocytosis by macrophages and PMNs. Endotoxin causes fever and sepsis. Produces a metalloprotease and proteins that suppress cell mediated immunity (mip proteins which are FK506 like). Defective cell mediated immunity predisposes to infection.

Pasteurella multocida

Characteristics	Small gram negative rods that causes wound infections.
Habitat & Transmission	Habitat is oral cavity of dogs and cats. Transmitted by animal bites.
Diagnosis	Gram negative rods.
Treatment	Penicillin G or Ampicillin.
Virulence Factors	Rapidly spreads in skin and other tissues. Releases endotoxin.

Proteus mirabilis

Characteristics	Highly motile gram negative rods that cause sepsis and urinary tract infections.
Habitat & Transmission	Habitat is the human GI tract, soil, and water. Transmission is due to contamination of the urinary tract by fecal flora.
Diagnosis	Gram negative, urease positive, highly motile, and non-lactose-fermenting on EMB and MacConkey's agar. TSI tube shows an alkaline slant/acid butt with H ₂ S. Does not convert tryptophan to indole.
Treatment	Ampicillin. Antibiotic resistance is a growing problem.
Pathogenesis	Endotoxin causes fever and shock. Urease produces ammonia which damages the urinary tract epithelium and initiates stone formation.

Proteus vulgaris

Characteristics	Highly motile gram negative rods that cause sepsis and urinary tract infections.
Habitat & Transmission	Habitat is the human GI tract, soil, and water. Transmission is due to contamination of the urinary tract by fecal flora.
Diagnosis	Gram negative, urease positive, highly motile, and non-lactose-fermenting on EMB and MacConkey's agar. TSI tube shows an alkaline slant/acid butt with H ₂ S. Converts tryptophan to indole.
Treatment	A third generation Cephalosporin. Antibiotic resistance is a growing problem.
Virulence Factors	Endotoxin causes fever and shock. Urease produces ammonia which damages the urinary tract epithelium and initiates struvite stone formation.

Pseudomonas aeruginosa

Characteristics	Gram negative rods that cause urinary tract infections, sepsis, and burn infections.
Habitat & Transmission	Habitat is standing water. About 10% of humans carry the organism on their skin or in their GI tracts. Transmission is by respiratory droplets, fecal-oral route, wound contamination and endotracheal intubation.
Diagnosis	Gram negative, aerobic, beta-hemolytic, non-lactose-fermenting colonies on EMB or MacConkey's agar, TSI tube shows an alkaline slant/alkaline butt, oxidase positive, and produces a blue-green pigment. Pigment is fluorescent under UV light.
Treatment	A Fluoroquinolone or ticarcillin. High-level antibiotic resistance is common.
Virulence Factors	Pilli mediate attachment to endothelial cells and lung secretions. Endotoxin produces fever and shock, and slime (capsule) is antiphagocytic. Exotoxin A inactivates EF-2 by ADP ribosylation and exoenzyme S ADP-ribosylates G-proteins to interfere with cell growth. Pyoverdine stops ciliary movement, Pyocyanin kills <i>S. aureus</i> , phospholipase degrades pulmonary surfactant, elastase degrades tissues and IgG, and alkaline protease degrades tissues.

Salmonella enteritidis

Characteristics	Gram negative and motile rod that causes sepsis and enterocolitis. Causes osteomyelitis in patients with sickle cell disease.
Habitat & Transmission	Habitat is the GI tract of humans and animals. Transmission is by the fecal-oral route.
Diagnosis	Gram negative, motile, facultative, non-lactose-fermenting colonies on EMB or MacConkey's agar, TSI tube shows alkaline slant/acid butt with gas and H ₂ S. Serotype (over 1,500 known) identified by agglutination reactions. Widal test detects antibodies in patient's blood to the O and H antigens.
Treatment	A Fluoroquinolone or Ceftriaxone for sepsis, but antibiotic resistance is a growing problem. Enterocolitis requires supportive care. Transmission can be prevented by public health measures (clean water and sewage disposal).
Pathogenesis	Invades intestinal mucosa by adhering to host cell cytoskeleton. Can then penetrate the epithelium and enter bloodstream. Endotoxin causes fever and shock. Flagellar antigens are biphasic.

Salmonella typhi

Characteristics	Gram negative rod that causes typhoid fever.
Habitat & Transmission	Habitat is the human gastrointestinal tract. Transmitted by the fecal-oral route.
Diagnosis	Gram negative, facultative, non-lactose fermenting on EMB and MacConkey's agar, and TSI tube shows alkaline slant/acid butt with H ₂ S. Serotyped by O, H, and Vi antigens. Widal test shows antibodies to O and H antigens in serum.
Treatment	A Fluoroquinolone or Ceftriaxone. Antibiotic resistance is common. Can be prevented by public health measures (clean water and sewage disposal) and by vaccination. Live and attenuated vaccines are available.
Virulence Factors	Invades intestinal mucosa by adhering to host cell cytoskeleton. Can then penetrate the epithelium and enter bloodstream. Endotoxin causes fever and the Vi antigen (capsule) is associated with virulence. Organism colonizes the reticuloendothelial system and can survive within macrophages. A carrier state can develop if the gall bladder is colonized.

Shigella species (S. dysenteriae and S. sonnei)

Characteristics	Gram negative rods that cause dysentery.
Habitat & Transmission	Habitat is the human large intestine. Transmission is by the fecal-oral route.
Diagnosis	Gram negative, non-lactose fermenting on EMB or MacConkey's agar, TSI tube shows an alkaline slant/acid butt. Species determined by biochemical reactions and serology.
Treatment	Usually, only supportive care is needed. However, a fluoroquinolone or trimethoprim-sulfamethoxazole can be given to patients with severe disease. Transmission can be prevented by public health measures (clean water and sewage disposal).
Virulence Factors	Invades the ileal and colonic mucosa, but do not penetrate the lamina propria. Endotoxin, hemolysin, and superoxide dismutase are produced. Shiga toxin is excreted and it removes adenine residues from the 28s rRNA to halt translation in host cells. Polymerizes actin to invade other cells. A small number (<10) organisms is required for infection.

Vibrio parahaemolyticus

Characteristics	Gram-negative comma shaped rods that cause watery diarrhea.
Habitat & Transmission	Habitat is seawater. Transmitted by eating raw fish.
Diagnosis	Gram-negative and grows in 8% NaCl.
Treatment	Supportive care. A Tetracycline can be used in severe cases.
Virulence Factors	Cholera-like toxin ADP-ribosylates a stimulatory G protein, causing an increase in cAMP levels within intestinal cells. This causes increased secretion of ions and water.

Vibrio cholerae

Characteristics	Gram negative comma-shaped rods that cause cholera.
Habitat & Transmission	Habitat is the human large intestine. Transmission is by the fecal-oral route.
Diagnosis	Gram negative, non-lactose fermenting, halophilic, and oxidase positive. Agglutination assay confirms identity.
Treatment	Supportive care. Tetracycline for severe cases. Can be prevented by public health measures (clean water and sewage disposal). A killed cell vaccine is available.
Virulence Factors	Cholera toxin ADP-ribosylates a stimulatory G protein, causing an increase in cAMP levels within intestinal cells. This causes increased secretion of ions and water. Fimbriae and flagella are produced, and these factors mediate tissue invasion. <i>Vibrio</i> hemagglutinin (a metalloprotease), mucinase and endotoxin are also released.

Yersinia enterocolitica

Characteristics	Small gram negative oval-shaped rods that cause enterocolitis.
Habitat & Transmission	Habitat is human and animal large intestine. Transmission is by the fecal-oral route.
Diagnosis	Gram negative, non-lactose fermenting on EMB or MacConkey's agar, and grows best at 25°C.
Treatment	Supportive care and Trimethoprim-Sulfamethoxazole for severe cases. Can be prevented by public health measures (clean water and sewage disposal).
Virulence Factors	Releases endotoxin and enterotoxin. Enterotoxin stimulates the production of cyclic GMP.

Yersinia pestis

Characteristics	Small gram negative rod that causes plague.
Habitat & Transmission	Habitat is rodents and prairie dogs. Transmission is by flea bite.
Diagnosis	Gram negative with bipolar staining, Wayson's stain shows "safety-pin" appearance, and immunofluorescence is used for definitive diagnosis. Not cultured due to hazard to lab personnel.
Treatment	Streptomycin with or without a Tetracycline. Quarantine infected patients. A killed organism vaccine is available. Transmission can be reduced by controlling the rodent population.
Pathogenesis	Produces endotoxin, an exotoxin, and has an antiphagocytic envelope. The V and W antigens are required for virulence.

MYCOBACTERIA***Mycobacterium avium-intracellulare complex ('MAC')***

Characteristics	Acid fast rods that cause a tuberculosis-like disease.
Habitat & Transmission	Habitat is water and soil. Transmission is by respiratory droplets.
Diagnosis	Acid fast rods that do not produce pigment. Antigens cross-react with <i>M. tuberculosis</i> . A PPD skin test with tuberculosis and MAC antigens will show a larger response to the pathogen present.
Treatment	Clarithromycin or azithromycin plus a fluoroquinolone or rifampin for 6-12 months. Drug resistance is common. Rifabutin or clarithromycin can be used for prophylaxis in AIDS patients.
Virulence Factors	Can survive and multiply within macrophages. Granulomas and caseation is due to a delayed hypersensitivity response to the organism.

Mycobacterium fortuitum-chelonae complex

Characteristics	Acid fast rods that infect heart valves and joints.
Habitat & Transmission	Habitat is water and soil.
Diagnosis	Acid fast rods that do not produce pigment. Antigens cross-react with <i>M. tuberculosis</i> in PPD test.
Treatment	Amikacin and doxycycline. Resistance is increasing. Surgical drainage and/or repair is required.
Virulence Factors	Can survive and multiply within macrophages. Granulomas and caseation is due to a delayed hypersensitivity response to the organism.

Mycobacterium kansasii

Characteristics	Acid fast rods that cause a tuberculosis-like disease.
Habitat & Transmission	Habitat is unknown.
Diagnosis	Acid fast rods that produce pigment only in light. Antigens cross-react with <i>M. tuberculosis</i> in PPD test.
Treatment	Isoniazid, rifampin, and ethambutol or streptomycin for 6-12 months. Antibiotic resistance is increasing.
Virulence Factors	Can survive and multiply within macrophages. Granulomas and caseation is due to a delayed hypersensitivity response to the organism.

Mycobacterium leprae

Characteristics	Acid fast rods that cause leprosy. Tuberculoid and lepromatous forms.
Habitat & Transmission	Habitat is the human skin and nerves. Transmission is by prolonged direct contact.
Diagnosis	Acid fast aerobic rods. Lepromin skin test is positive in the tuberculoid form and negative in the lepromatous form. Cultured in armadillos.
Treatment	Dapsone and rifampin for 2 years to treat the tuberculoid form. Clofazamine is added to the regimen for the lepromatous form. Dapsone can prevent the disease in exposed individuals.
Virulence Factors	Can survive and multiply within macrophages. Forms lesions in cool parts of the body, causing local pathology. In tuberculoid leprosy, a CD4+ T-Cell (TH1 subclass) response is initiated (activated macrophages and granuloma formation). In lepromatous leprosy, a CD8+ T-Cell response is initiated, which results in the production of anti- <i>M. leprae</i> antibodies. This response is not sufficient to control the infection.

Mycobacterium marinum

Characteristics	Acid fast rods that cause swimming pool granulomas.
Habitat & Transmission	Habitat is fresh and salt water. Transmission is through wounds.
Diagnosis	Acid fast rods that produce pigment only in light. Antigens cross-react with <i>M. tuberculosis</i> in PPD test.
Treatment	Minocycline.
Virulence Factors	Can survive and multiply within macrophages. Granulomas and caseation is due to a delayed hypersensitivity response to the organism.

Mycobacterium scrofulaceum

Characteristics	Acid fast rods that cause scrofula.
Habitat & Transmission	Habitat is fresh water. Transmission is by ingestion or respiratory droplets.
Diagnosis	Acid fast rods that produce pigment in light and dark. Antigens cross-react with <i>M. tuberculosis</i> in PPD test.
Treatment	Excision of infected lymph nodes.
Virulence Factors	Can survive and multiply within macrophages. Granulomas and caseation is due to a delayed hypersensitivity response to the organism.

Mycobacterium tuberculosis

Characteristics	Acid fast rods that cause tuberculosis.
Habitat & Transmission	Habitat is the human respiratory tract. Transmission is via respiratory droplets.
Diagnosis	Aerobic acid-fast rods that can be seen with Ziehl-Neelsen or Kinyoun stains. Grows slowly on Lowenstein-Jensen medium, produces niacin, and is catalase-negative. PPD skin test used to determine if person has been exposed to <i>M. tuberculosis</i> .
Treatment	Isoniazid, rifampin, and pyrazinamide for 6-12 months. Isoniazid resistance is increasing. Isoniazid can be taken to prevent disease in exposed individuals. The live BCG vaccine limits, but does not prevent infection.
Pathogenesis	Can survive and multiply within macrophages because sulfatides (surface glycolipids that contain sulfur) prevent the fusion of phagosomes to lysosomes. The cord factor (trehalose mycolate) and Wax D stimulate granuloma formation due to a delayed hypersensitivity response. LAM, an endotoxin like substance, induces macrophages to secrete TNF-alpha and IL-10. A CD8+ T-Cell response is required to kill the organism.

ACTINOMYCETES***Actinomyces israeli***

Characteristics	Gram positive filaments that cause actinomycosis (abscesses with draining sinuses).
Habitat & Transmission	Habitat is crevices surrounding teeth. Introduced systematically by trauma or dental abscesses.
Diagnosis	Gram positive filaments with "Sulfur granules". Filaments are weakly acid-fast.
Treatment	Penicillin G and surgical drainage. Can be prevented with good dental hygiene.
Pathogenesis	No toxins or virulence factors known.

Nocardia asteroides

Characteristics	Gram positive and acid fast branching rods that cause nocardiosis.
Habitat & Transmission	Habitat is the soil. Transmission is via soil particles.
Diagnosis	Aerobic, gram positive, and stains with modified Ziehl-Neelsen stain (acid fast).
Treatment	Trimethoprim-Sulfamethoxazole.
Pathogenesis	No toxins or virulence factors known.

MYCOPLASMAS***Mycoplasma hominis***

Characteristics	Small cell-wall less bacteria that causes pelvic inflammatory disease.
Habitat & Transmission	Habitat is unknown.
Diagnosis	Because of small size and lack of cell wall, microscopy is not useful. Compliment fixation tests are used for diagnosis. Requires cholesterol and nucleotides for growth. Colonies have a 'fried egg' appearance on agar.
Treatment	Erythromycin.
Virulence Factors	Produces hydrogen peroxide and cytolytic enzymes.

Mycoplasma pneumoniae

Characteristics	Small cell-wall less bacteria that cause "atypical" pneumonia.
Habitat & Transmission	Habitat is the human respiratory tract. Transmission is via respiratory droplets.
Diagnosis	Because of small size and lack of cell wall, microscopy is not useful. Cold-agglutinin test and compliment fixation tests are used for diagnosis. Requires cholesterol and nucleotides for growth. Colonies have a 'fried egg' appearance on agar.
Treatment	Erythromycin or a Tetracycline.
Pathogenesis	Produces hydrogen peroxide and cytolytic enzymes.

Ureaplasma urealyticum

Characteristics	Small cell-wall less bacteria that causes nongonococcal urethritis.
Habitat & Transmission	Habitat is the human urinary tract.
Diagnosis	Because of small size and lack of cell wall, microscopy is not useful. Urease positive. Compliment fixation tests are used for diagnosis. Requires cholesterol and nucleotides for growth. Colonies have a 'fried egg' appearance on agar.
Treatment	Erythromycin.
Virulence Factors	Produces hydrogen peroxide, cytolytic enzymes, and urease.

SPIROCHETES

Borrelia burgdorferi

Characteristics	Spiral shaped organisms that cause Lyme disease.
Habitat & Transmission	Habitat is wild animals (rodents and deer). Transmitted by ixoid ticks.
Diagnosis	Serology is used to make the diagnosis. Organism can be grown on Kelly's medium.
Treatment	Doxycycline for early stages, penicillin G for late stages.
Pathogenesis	Organism disseminates in bloodstream, causing damage to heart, joints, and central nervous system by polyclonal activation of host B-cells by outer membrane proteins.

Borrelia recurrentis

Characteristics	Spiral shaped organism that causes relapsing fever.
Habitat & Transmission	Habitat is humans. Transmission is via body louse.
Diagnosis	Can be seen by dark-field microscopy. Diagnosis is made by serology.
Treatment	A Tetracycline.
Virulence Factors	Cell wall lipids have LPS-like activity and surface antigens undergo periodic antigenic shifts.

Leptospira interrogans

Characteristics	Spiral shaped organism that causes leptospirosis.
Habitat & Transmission	Habitat is wild and domestic animals. Transmission is via animal urine.
Diagnosis	Can be seen by dark-field microscopy. Diagnosis is made by serology. Organism is beta hemolytic.
Treatment	Penicillin G. Transmission can be reduced by vaccinating livestock.
Pathogenesis	Cell wall lipids have LPS-like activity and beta-hemolysin is released.

Treponema pallidum

Characteristics	Spiral shaped organism that causes syphilis.
Habitat & Transmission	Habitat is the human genital tract. Transmission is sexual and transplacental.
Diagnosis	Dark-field microscopy or immunofluorescence needed to see organism. VDRL and RPR nontreponemal tests are used for screening (anti-cardiolipin antibody tests). FTA-ABS test is used to confirm the diagnosis.
Treatment	Penicillin G. Resistance is not reported.
Virulence Factors	Binds to host fibronectin and releases antigens that cause vasculitis due to the host antibody response against these antigens. This vasculitis compromises the microcirculation of larger arteries and the CNS.

Treponema pertenue

Characteristics	Spiral shaped organism that causes yaws.
Habitat & Transmission	Habitat is humans.
Diagnosis	Can be seen by dark-field microscopy. Diagnosis is made by serology. Antigens cross react with <i>T. pallidum</i> giving a positive VDRL test.
Treatment	Penicillin G.
Virulence Factors	Cell wall lipids have LPS-like activity.

CHLAMYDIA***Chlamydia pneumoniae***

Characteristics	Obligate intracellular parasite that causes atypical pneumonia.
Habitat & Transmission	Habitat is humans. Transmission is via respiratory droplets.
Diagnosis	Cytoplasmic inclusion bodies seen on Giemsa or fluorescent-antibody staining. Diagnosis made by serology.
Treatment	A Tetracycline
Virulence Factors	Elementary bodies have receptors that bind to microvilli and ciliated epithelial cells.

Chlamydia psittaci

Characteristics	Obligate intracellular parasite that causes psittacosis.
Habitat & Transmission	Habitat is psittacine birds. Transmission is via bird feces particles.
Diagnosis	Cytoplasmic inclusion bodies seen on Giemsa or fluorescent-antibody staining. Diagnosis made by serology.
Treatment	A Tetracycline
Virulence Factors	Elementary bodies have receptors that bind to microvilli and ciliated epithelial cells.

Chlamydia trachomatis

Characteristics	Obligate intracellular parasite that causes nongonococcal urethritis, cervicitis, trachoma, conjunctivitis, and lymphogranuloma venereum.
Habitat & Transmission	Habitat is the human eyes and genital tract. Transmission is by sexual contact, hand to eye contact, and during vaginal delivery.
Diagnosis	Cytoplasmic inclusion bodies seen on immunofluorescence or Giemsa stain. Stains brown with iodine.
Treatment	Azithromycin (single dose) or a Tetracycline.
Virulence Factors	Elementary bodies have receptors that bind to microvilli and ciliated epithelial cells.

RICKETTSIAE***Coxiella burnetii***

Characteristics	Obligate intracellular parasite that causes Q fever.
Habitat & Transmission	Habitat is wild and domestic animals. Transmission is from contaminated urine and feces.
Diagnosis	Diagnosis is made by serology. Weil-Felix test is negative.
Treatment	A Tetracycline. A killed cell vaccine is available.
Virulence Factors	No toxins or virulence factors known.

Rickettsia rickettsia

Characteristics	Obligate intracellular parasite that causes Rocky Mountain spotted fever.
Habitat & Transmission	Habitat is wild animals. Transmitted via tick bite.
Diagnosis	Diagnosis is made by serology or Weil-Felix test.
Treatment	A Tetracycline.
Virulence Factors	Organism invades vascular endothelium by polymerizing actin to cause vasculitis. Releases LPS-like compounds and phospholipase.