



Pathogenic bacteria

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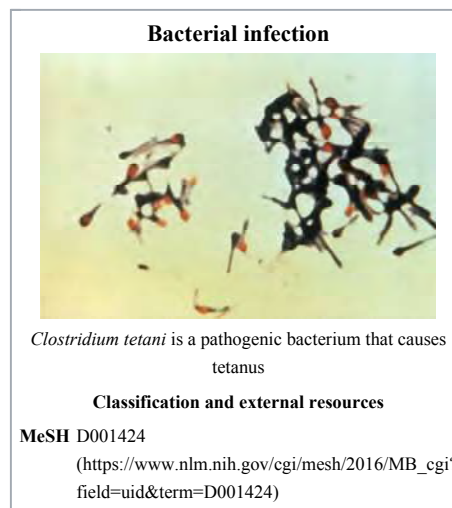
Pathogenic bacteria are bacteria that can cause infection. This article deals with human pathogenic bacteria.

Although most bacteria are harmless or often beneficial, several are pathogenic. One of the bacterial diseases with the highest disease burden is tuberculosis, caused by the bacterium *Mycobacterium tuberculosis*, which kills about 2 million people a year, mostly in sub-Saharan Africa. Pathogenic bacteria contribute to other globally important diseases, such as pneumonia, which can be caused by bacteria such as *Streptococcus* and *Pseudomonas*, and foodborne illnesses, which can be caused by bacteria such as *Shigella*, *Campylobacter*, and *Salmonella*. Pathogenic bacteria also cause infections such as tetanus, typhoid fever, diphtheria, syphilis, and leprosy. Pathogenic bacteria are also the cause of high infant mortality rates in developing countries.^[1]

Koch's postulates are the standard to establish a causative relationship between a microbe and a disease.

Contents

- 1 Diseases
 - 1.1 Pathogenic susceptibility
 - 1.2 Intracellular
 - 1.3 Infections in specific tissue
- 2 Mechanisms
 - 2.1 Nutrients
 - 2.1.1 Direct damage
 - 2.1.2 Toxin production
- 3 Identification
- 4 Treatment
- 5 List of genera and microscopy features
- 6 List of species and clinical characteristics
- 7 See also
- 8 References
- 9 External links



Diseases

Each species has specific effect and causes symptoms in people who are infected. Some, if not most people who are infected with a pathogenic bacteria do not have symptoms. Immuno-compromised individuals are more susceptible to pathogenic bacteria.

Pathogenic susceptibility

Some pathogenic bacteria cause disease under certain conditions, such entry through the skin via a cut, through sexual activity or an compromised immune function.

Streptococcus and *Staphylococcus* are part of the normal skin microbiota and typically reside on healthy skin or in the nasopharyngeal region. Yet these species can potentially initiate skin infections. They are also able to cause sepsis, pneumonia, meningitis. These infections can become quite serious creating a systemic inflammatory response resulting in massive vasodilation, shock, and death.^[2]

Other bacteria are opportunistic pathogens and cause disease mainly in people suffering from immunosuppression or cystic fibrosis Examples of these opportunistic pathogens include *Pseudomonas aeruginosa*, *Burkholderia cenocepacia*, and *Mycobacterium avium*.^{[3][4]}

Intracellular

Obligate intracellular parasites (e.g. Chlamydia, Ehrlichia, Rickettsia) have the ability to only grow and replicate inside other cells. Even these intracellular infections may be asymptomatic, requiring an incubation period. An example of this *Rickettsia* which causes typhus. Another causes Rocky Mountain spotted fever.

Chlamydia is a phylum of intracellular parasites. These pathogens can cause pneumonia or urinary tract infection and may be involved in coronary heart disease.^[5]

Other groups of intracellular bacterial pathogens include *Salmonella*, *Neisseria*, *Brucella*, *Mycobacterium*, *Nocardia*, *Listeria*, *Francisella*, *Legionella*, and *Yersinia pestis*. These can exist intracellularly, but can exist outside of host cells.

Infections in specific tissue

Bacterial pathogens often cause infection in specific areas of the body. Others are generalists.

- Bacterial vaginosis is caused by bacteria that change the vaginal microbiota caused by an overgrowth of bacteria that crowd out the Lactobacilli species that maintain healthy vaginal microbial populations.
- Other non-bacterial vaginal infections include: yeast infection (candidiasis), *Trichomonas vaginalis* (trichomoniasis).^{[6][7]}
- Bacterial meningitis is a bacterial inflammation of the meninges, that is, the protective membranes covering the brain and spinal cord.
- Bacterial pneumonia is a bacterial infection of the lungs.
- Urinary tract infection is predominantly caused by bacteria. Symptoms include the strong and frequent sensation or urge to urinate, pain during urination, and urine that is cloudy.^[8] The main causal agent is *Escherichia coli*. Urine is typically sterile but contains a variety of salts, and waste products.^[9] Bacteria can ascend into the bladder or kidney and causing cystitis and nephritis.
- Bacterial gastroenteritis is caused by enteric, pathogenic bacteria. These pathogenic species are usually distinct from the usually harmless bacteria of the normal gut flora. But a different strain of the same species may be pathogenic. The distinction is sometimes difficult as in the case of *Escherichia*.
- Bacterial skin infections include:
 - Impetigo is a highly contagious bacterial skin infection commonly seen in children.^[10] It is caused by *Staphylococcus aureus*, and *Streptococcus pyogenes*.^[11]
 - Erysipelas is an acute streptococcus bacterial infection^[12] of the deeper skin layers that spreads via with lymphatic system.
 - Cellulitis is a diffuse inflammation^[13] of connective tissue with severe inflammation of dermal and subcutaneous layers of the skin. Cellulitis can be caused by normal skin flora or by contagious contact, and usually occurs through open skin, cuts, blisters, cracks in the skin, insect bites, animal bites, burns, surgical wounds, intravenous drug injection, or sites of intravenous catheter insertion. In most cases it is the skin on the face or lower legs that is affected, though cellulitis can occur in other tissues.

Mechanisms

Nutrients

Iron is required for humans, as well as the growth of most bacteria. To obtain free iron, some pathogens secrete proteins called siderophores, which take the iron away from iron-transport proteins by binding to the iron even more tightly. Once the iron-siderophore complex is formed, it is taken up by siderophore receptors on the bacterial surface and then that iron is brought into the bacterium.^[14]

Direct damage

Once pathogens attach to host cells, they can cause direct damage as the pathogens use the host cell for nutrients and produce waste products. As pathogens multiply and divide inside host cells, the cells usually rupture and the intercellular bacteria are released. Some bacteria such as *E. coli*, *Shigella*, *Salmonella*, and *Neisseria gonorrhoeae*, can induce host epithelial cells to engulf them in a process resembling phagocytosis. The pathogens can then disrupt host cells as they pass through them and be extruded from host cells by a reverse phagocytosis process, enabling them to enter other host cells. Some bacteria can also penetrate host cells by excreting enzymes and by their own motility; such penetration can itself damage the host cell.^[14]

Toxin production

Toxins are poisonous substances that are produced by certain microorganisms and are often the primary factor contributing to the pathogenic properties of the microorganisms. Endotoxins are the lipid portions of lipopolysaccharides that are part of the outer membrane of the cell wall of gram negative bacteria. Endotoxins are released when the bacteria lyses, which is why after antibiotic treatment symptoms can at first worsen as the bacteria are killed and they release their endotoxins. Exotoxins are proteins produced inside pathogenic bacteria as part of their growth and metabolism, most common in gram positive bacteria. The exotoxins are released when the bacteria die and the cell wall breaks apart. Exotoxins are highly specific in the effects on body tissues and work by destroying particular parts of the host cell or by inhibiting certain metabolic functions. Exotoxins are among the most lethal known substances, only 1 mg of the botulinum exotoxin is enough to kill one million guinea pigs. Diseases caused this way are often caused by minute amounts of exotoxins, not by the bacteria themselves.^[14]

Identification

Typically identification is done by growing the organism in a wide range of cultures which can take up to 48 hours. The growth is then visually or genomically identified. The cultured organism is then subjected to antibiotics to observe reaction to help further identify species and strain.^[15]

Treatment

Bacterial infections may be treated with antibiotics, which are classified as bacteriocidal if they kill bacteria or bacteriostatic if they just prevent bacterial growth. There are many types of antibiotics and each class inhibits a process that is different in the pathogen from that found in the host. For example, the antibiotics chloramphenicol and tetracyclin inhibit the bacterial ribosome but not the structurally different eukaryotic ribosome, so they exhibit selective toxicity.^[16] Antibiotics are used both in treating human disease and in intensive farming to promote animal growth. Both uses may be contributing to the rapid development of antibiotic resistance in bacterial populations.^[17] Phage therapy can also be used to treat certain bacterial infections.^[18] Infections can be prevented by antiseptic measures such as sterilizing the skin prior to piercing it with the needle of a syringe and by proper care of indwelling catheters. Surgical and dental instruments are also sterilized to prevent infection by bacteria. Disinfectants such as bleach are used to kill bacteria or other pathogens on surfaces to prevent contamination and further reduce the risk of infection. Bacteria in food are killed by cooking to temperatures above 73 °C (163 °F).

List of genera and microscopy features

Many genera contain pathogenic bacteria species. They often possess characteristics that help to classify and organize them into groups. The following is a partial listing.

Genus	Species	Gram staining	Shape	Oxygen requirement	Intra/Extracellular
<i>Bacillus</i> ^[19]	<ul style="list-style-type: none"> <i>Bacillus anthracis</i> <i>Bacillus cereus</i> 	Positive	Rods	Facultative anaerobic	Extracellular
<i>Bartonella</i> ^[19]	<ul style="list-style-type: none"> <i>Bartonella henselae</i> <i>Bartonella quintana</i> 	Negative	Rods	Aerobic	Facultative intracellular
<i>Bordetella</i> ^[19]	<ul style="list-style-type: none"> <i>Bordetella pertussis</i>^{[20][21]} 	Negative	Small coccobacilli	Aerobic	Extracellular
<i>Borrelia</i> ^[19]	<ul style="list-style-type: none"> <i>Borrelia burgdorferi</i> <i>Borrelia garinii</i> <i>Borrelia afzelii</i> <i>Borrelia recurrentis</i> 	Negative, stains poorly	spirochete	Anaerobic	Extracellular
<i>Brucella</i> ^[19]	<ul style="list-style-type: none"> <i>Brucella abortus</i> <i>Brucella canis</i> <i>Brucella melitensis</i> <i>Brucella suis</i> 	Negative	coccobacilli	Aerobic	Intracellular
<i>Campylobacter</i> ^[19]	<ul style="list-style-type: none"> <i>Campylobacter jejuni</i> 	Negative	Spirochete Bacillus	microaerophilic	extracellular
<i>Chlamydia</i> and <i>Chlamydophila</i> ^[19]	<ul style="list-style-type: none"> <i>Chlamydia pneumoniae</i> <i>Chlamydia trachomatis</i> <i>Chlamydophila psittaci</i> 	(not Gram-stained)	Small, round, ovoid	Facultative or strictly aerobic	Obligate intracellular
<i>Clostridium</i> ^[19]	<ul style="list-style-type: none"> <i>Clostridium botulinum</i> <i>Clostridium difficile</i> <i>Clostridium perfringens</i> <i>Clostridium tetani</i> 	Positive	Large, blunt-ended rods	Obligate anaerobic	extracellular
<i>Corynebacterium</i> ^[19]	<ul style="list-style-type: none"> <i>Corynebacterium diphtheriae</i>^{[21][22][23]} 	Positive (unevenly)	bacilli	Mostly facultative anaerobic	extracellular
<i>Enterococcus</i> ^{[21][24]}	<ul style="list-style-type: none"> <i>Enterococcus faecalis</i> <i>Enterococcus faecium</i> 	Positive	Cocci	Facultative Anaerobic	extracellular
<i>Escherichia</i> ^{[1][21][25]}	<ul style="list-style-type: none"> <i>Escherichia coli</i> 	Negative	Bacillus	Facultative anaerobic	extracellular or intracellular
<i>Francisella</i> ^[19]	<ul style="list-style-type: none"> <i>Francisella tularensis</i> 	Negative	coccobacillus	strictly aerobic	Facultative intracellular
<i>Haemophilus</i>	<ul style="list-style-type: none"> <i>Haemophilus influenzae</i>^{[21][26]} 	Negative	coccobacilli to long and slender filaments		extracellular
<i>Helicobacter</i>	<ul style="list-style-type: none"> <i>Helicobacter pylori</i>^[27] 	Negative	Spirochete	Microaerophile	extracellular
<i>Legionella</i> ^[19]	<ul style="list-style-type: none"> <i>Legionella pneumophila</i> 	Negative, stains poorly	cocobacilli	aerobic	facultative intracellular
<i>Leptospira</i> ^{[21][28]}	<ul style="list-style-type: none"> <i>Leptospira interrogans</i> <i>Leptospira santarosai</i> <i>Leptospira weilii</i> <i>Leptospira noguchii</i> 	Negative, stains poorly	Spirochete	Strictly aerobic	extracellular
<i>Listeria</i> ^[19]	<ul style="list-style-type: none"> <i>Listeria monocytogenes</i> 	Positive, darkly	Slender, short rods	Facultative Anaerobic	intracellular
<i>Mycobacterium</i> ^[19]	<ul style="list-style-type: none"> <i>Mycobacterium leprae</i> <i>Mycobacterium tuberculosis</i> <i>Mycobacterium ulcerans</i> 	(none)	Long, slender rods	aerobic	extracellular
<i>Mycoplasma</i> ^[19]	<ul style="list-style-type: none"> <i>Mycoplasma pneumoniae</i> 	(none)	'fried egg' appearance, no cell wall	Mostly facultative anaerobic; <i>M. pneumoniae</i> strictly aerobic	extracellular
<i>Neisseria</i> ^{[21][29]}	<ul style="list-style-type: none"> <i>Neisseria gonorrhoeae</i> <i>Neisseria meningitidis</i> 	Negative	Kidney bean-shaped	aerobic	<i>Gonococcus</i> : facultative intracellular <i>N. meningitidis</i> : extracellular
<i>Pseudomonas</i> ^{[21][30]}	<ul style="list-style-type: none"> <i>Pseudomonas aeruginosa</i> 	Negative	rods	Obligate aerobic	extracellular

<i>Rickettsia</i> ^[19]	<ul style="list-style-type: none"> ▪ <i>Rickettsia rickettsii</i> 	Negative, stains poorly	Small, rod-like coccobacillary	Aerobic	Obligate intracellular
<i>Salmonella</i> ^[19]	<ul style="list-style-type: none"> ▪ <i>Salmonella typhi</i> ▪ <i>Salmonella typhimurium</i> 	Negative	Bacillus shape	Facultative anaerobica	Facultative intracellular
<i>Shigella</i> ^{[21][31]}	<ul style="list-style-type: none"> ▪ <i>Shigella sonnei</i> 	Negative	rods	Facultative anaerobic	extracellular
<i>Staphylococcus</i> ^[1]	<ul style="list-style-type: none"> ▪ <i>Staphylococcus aureus</i> ▪ <i>Staphylococcus epidermidis</i> ▪ <i>Staphylococcus saprophyticus</i> 	Positive, darkly	Round cocci	Facultative anaerobic	extracellular, facultative intracellular
<i>Streptococcus</i> ^[19]	<ul style="list-style-type: none"> ▪ <i>Streptococcus agalactiae</i> ▪ <i>Streptococcus pneumoniae</i> ▪ <i>Streptococcus pyogenes</i> 	Positive	ovoid to spherical	Facultative anaerobic	extracellular
<i>Treponema</i> ^[19]	<ul style="list-style-type: none"> ▪ <i>Treponema pallidum</i> 	Negative, stains poorly	Spirochete	Aerobic	extracellular
<i>Ureaplasma</i> ^[1]	<ul style="list-style-type: none"> ▪ <i>Ureaplasma urealyticum</i> 	Stains poorly ^[32]	indistinct, 'fried egg' appearance, no cell wall	anaerobic	extracellular
<i>Vibrio</i> ^{[21][21][33]}	<ul style="list-style-type: none"> ▪ <i>Vibrio cholerae</i> 	Negative	Spiral with single polar flagellum	Facultative anaerobic	extracellular
<i>Yersinia</i> ^{[21][34]}	<ul style="list-style-type: none"> ▪ <i>Yersinia pestis</i> ▪ <i>Yersinia enterocolitica</i> ▪ <i>Yersinia pseudotuberculosis</i> 	Negative, bipolarly	Small rods	Facultative Anaerobe	Intracellular

List of species and clinical characteristics

This is description of the more common genera and species presented with their clinical characteristics and treatments.

Species of human pathogenic bacteria

Species	Transmission	Diseases	Treatment	Prevention
<i>Actinomyces israelii</i>	Oral flora ^[35]	Actinomycosis: ^[35] painful abscesses in the mouth, lungs, ^{[36][37]} or gastrointestinal tract. ^[22]	Prolonged penicillin G and drainage ^[35]	
<i>Bacillus anthracis</i>	Contact with cattle, sheep, goats and horses ^[38] Spores enter through inhalation or through abrasions ^[21]	Anthrax: pulmonary, gastrointestinal and/or cutaneous symptoms. ^[35]	Penicillin Doxycycline Ciprofloxacin Raxibacumab ^[40]	Anthrax vaccine ^[21] Autoclaving of equipment ^[21]
<i>Bacteroides fragilis</i>	Gut flora ^[35]	Abscesses in gastrointestinal tract, pelvic cavity and lungs ^[35]	metronidazole ^[35]	Wound care ^[41] Aspiration prevention ^[41]
<i>Bordetella pertussis</i>	Contact with respiratory droplets expelled by infected human hosts. ^[21]	Whooping cough ^{[21][35]} Secondary bacterial pneumonia ^[21]	Macrolides ^[21] such as erythromycin, ^{[21][35]} before paroxysmal stage ^[35]	Pertussis vaccine, ^{[21][35]} such as in DPT vaccine ^{[21][35]}
<i>Borrelia burgdorferi</i> ^{[21][35]} <i>B. garinii</i> ^[21] <i>B. afzelii</i> ^[21]	Ixodes ticks reservoir in deer and mice ^{[21][35]}	<ul style="list-style-type: none"> Lyme disease^[21] (<i>B. burgdorferi</i>)^[35] Relapsing fever 	<p>Early stages of Lyme disease:^[21]</p> <ul style="list-style-type: none"> doxycycline^{[21][35]} amoxicillin^{[21][35]} ceftriaxone in neurological involvement^[35] <p>Chronic Lyme disease:</p> <ul style="list-style-type: none"> penicillin G^[35] <p>Relapsing fever:</p> <ul style="list-style-type: none"> doxycycline^[35] 	Wearing clothing that limits skin exposure to ticks. ^[21] Insect repellent. ^[21] Avoid areas where ticks are found. ^[21]
<i>Brucella abortus</i> <i>B. canis</i> <i>B. melitensis</i> <i>B. suis</i>	Direct contact with infected animal ^[21] Oral, by ingestion of unpasteurized milk or milk products ^[21]	Brucellosis	doxycycline ^[21] streptomycin or gentamicin ^[21]	
<i>Campylobacter jejuni</i>	Fecal-oral from animals (mammals and fowl) ^{[21][35]} Uncooked meat (especially poultry) ^{[21][35]} Contaminated water ^[21]	<ul style="list-style-type: none"> Enteritis,^[21] bloody diarrhea^[35] Guillain–Barré syndrome^[35] 	Treat symptoms ^[21] Fluoroquinolone ^[35] such as ciprofloxacin ^[21] in severe cases ^[21]	Good hygiene ^[21] Avoiding contaminated water ^[21] Pasteurizing milk and milk products ^[21] Cooking meat (especially poultry) ^[21]
<i>C. pneumoniae</i>	Respiratory droplets ^{[21][35]}	Atypical pneumonia ^[35]	Doxycycline ^{[21][35]} Erythromycin ^{[21][35]}	None ^[21]
<i>Chlamydia trachomatis</i>	vaginal sex ^[21] oral sex ^[21] anal sex ^[21] Vertical from mother to newborn(ICN) ^[21] Direct or contaminated surfaces and flies (trachoma) ^[21]	Trachoma ^{[21][35]} Neonatal conjunctivitis ^{[21][35]} Neonatal pneumonia ^{[21][35]} Nongonococcal urethritis (NGU) ^{[21][35]} Urethritis ^{[21][35]} Pelvic inflammatory disease ^{[21][35]} Epididymitis ^{[21][35]} Prostatitis ^{[21][35]} Lymphogranuloma venereum (LGV) ^{[21][35]}	Erythromycin ^{[21][35]} (adults) ^[35] Doxycycline ^{[21][35]} (infants and pregnant women) ^[35]	Erythromycin or silver nitrate in newborn's eyes ^[21] Safe sex ^[21] Abstinence ^[21]
<i>Chlamydophila psittaci</i>		Psittacosis		-

		Inhalation of dust with secretions or feces from birds (e.g. parrots)		Tetracycline ^[21] Doxycycline ^[21] Erythromycin ^[21]	
<i>Clostridium</i>	<i>C. botulinum</i>	Spores from soil, ^{[21][35]} persevere in canned food, smoked fish and honey ^[35]	Botulism: Mainly muscle weakness and paralysis ^[35]	Antitoxin ^{[21][35]} Penicillin ^[35] Hyperbaric oxygen ^[35] Mechanical ventilation ^[35]	Proper food preservation techniques
	<i>C. difficile</i>	Gut flora, ^{[21][35]} overgrowing when other flora is depleted ^[21]	Pseudomembranous colitis ^{[21][35]}	Discontinuing responsible antibiotic ^{[21][35]} Vancomycin or metronidazole if severe ^{[21][35]}	Fecal bacteriotherapy
	<i>C. perfringens</i>	Spores in soil ^{[21][35]} Vaginal flora and gut flora ^[21]	Anaerobic cellulitis ^{[21][35]} Gas gangrene ^{[21][35]} Acute food poisoning ^{[21][35]}	Gas gangrene: Debridement or amputation ^{[21][35]} Hyperbaric medicine ^{[21][35]} High doses of doxycycline ^[21] or penicillin G ^{[21][35]} and clindamycin ^[35] Food poisoning: Supportive care is sufficient ^[21]	Appropriate food handling ^[21]
	<i>C. tetani</i>	Spores in soil, skin penetration through wounds ^{[21][35]}	Tetanus ^[21]	Tetanus immune globulin ^{[21][35]} Sedatives ^[21] Muscle relaxants ^[21] Mechanical ventilation ^{[21][35]} Penicillin or metronidazole ^[35]	Tetanus vaccine (such as in the DPT vaccine) ^[21]
<i>Corynebacterium diphtheriae</i>		respiratory droplets part of human flora	Diphtheria	Horse serum antitoxin Erythromycin Penicillin	DPT vaccine
<i>Ehrlichia</i>	<i>E. canis</i> ^[35]				
	<i>E. chaffeensis</i> ^[35]	Dog tick ^[35]	Ehrlichiosis ^[35]	<ul style="list-style-type: none"> ▪ doxycycline^[35] ▪ rifampin^[35] 	
<i>Enterococcus</i>	<i>E. faecalis</i> <i>E. faecium</i>	Part of gut flora, ^[35] opportunistic or entering through GI tract or urinary system wounds ^[21]	bacterial endocarditis ^[35] biliary tract infections ^[35] urinary tract infections ^[35]	Ampicillin (combined with aminoglycoside in endocarditis) ^[35] Vancomycin ^[21]	No vaccine Hand washing and other nosocomial prevention
	<i>Escherichia</i>	<i>E. coli</i> (generally)	<ul style="list-style-type: none"> ▪ Gut flora,^{[21][35]} and in urinary tract^[35] ▪ Spreading extraintestinally or proliferating in the GI tract^[21] 	<ul style="list-style-type: none"> ▪ Diarrhea^{[21][35]} ▪ Urinary tract infections (UTI)^{[21][35]} ▪ Meningitis in infants^{[21][35]} ▪ Hospital-acquired pneumonia^[35] ▪ Hospital-acquired sepsis^[35] 	UTI: ^[21] (resistance-tests are required first) <ul style="list-style-type: none"> ▪ Co-trimoxazole ▪ Fluoroquinolone, e.g. ciprofloxacin Meningitis: ^[21] <ul style="list-style-type: none"> ▪ Cephalosporin (e.g. cefotaxime) and gentamicin combination
Enterotoxigenic <i>E. coli</i> (ETEC)		<ul style="list-style-type: none"> ▪ Fecal-oral^[35] through food and water^[21] ▪ Direct physical contact^[21] 	<ul style="list-style-type: none"> ▪ Traveller's diarrhea^{[21][35]} 	Diarrhea: ^[21] <ul style="list-style-type: none"> ▪ Antibiotics above shorten duration 	
Enteropathogenic <i>E. coli</i>		<ul style="list-style-type: none"> ▪ Vertical, in utero or at birth^[21] 	<ul style="list-style-type: none"> ▪ Diarrhea in infants^[21] 		

	Enteroinvasive E.coli (EIEC)	<ul style="list-style-type: none"> Fecal-oral^[42] 	<ul style="list-style-type: none"> bloody diarrhea and fever^[35] 	<ul style="list-style-type: none"> Electrolyte and fluid replacement 	
	Enterohemorrhagic (EHEC), including <i>E. coli</i> O157:H7	<ul style="list-style-type: none"> Reservoir in cattle^[21] 	<ul style="list-style-type: none"> bloody diarrhea^{[21][35]} Hemolytic-uremic syndrome^{[21][35]} 		
<i>Francisella tularensis</i>		<ul style="list-style-type: none"> vector-borne by arthropods^[21] Infected wild or domestic animals, birds or house pets^[21] 	Tularemia: Fever, ulceration at entry site and/or lymphadenopathy. ^[43] Can cause severe pneumonia. ^[43]	<ul style="list-style-type: none"> Streptomycin^[21] Gentamicin^[21] 	<ul style="list-style-type: none"> Avoiding insect vectors^[21] Precautions when handling wild animals or animal products^[21]
<i>Haemophilus influenzae</i>		<ul style="list-style-type: none"> Droplet contact^[21] Human flora of e.g. upper respiratory tract^[21] 	<ul style="list-style-type: none"> Bacterial meningitis^{[21][35]} Upper respiratory tract infections^{[21][35]} Pneumonia,^{[21][35]} bronchitis^[21] Septic arthritis in infants^[35] 	Meningitis: ^[21] (resistance-tests are required first) <ul style="list-style-type: none"> Third generation cephalosporin, e.g. cefotaxime or ceftriaxone^[21] Ampicillin and sulbactam combination^[21] 	<ul style="list-style-type: none"> Hib vaccine to infants^{[21][35]} Rifampin prophylactically^[21]
<i>Helicobacter pylori</i>		<ul style="list-style-type: none"> Colonizing stomach^[21] Unclear person-to-person transmission^[21] 	<ul style="list-style-type: none"> Peptic ulcer^{[21][35]} Chronic gastritis^[35] Risk factor for gastric carcinoma and gastric B-cell lymphoma^[21] 	<ul style="list-style-type: none"> Tetracycline, metronidazole and bismuth salt combination^[21] 	(No vaccine or preventive drug) ^[21]
<i>Klebsiella pneumoniae</i>		<ul style="list-style-type: none"> Mouth, skin, and gut flora.^[44] Pneumonia upon aspiration 	<ul style="list-style-type: none"> Klebsiella pneumonia, with significant lung necrosis and hemoptysis^[35] Hospital-acquired Urinary tract infection and sepsis^[35] 	<ul style="list-style-type: none"> 3rd generation cephalosporin^[35] ciprofloxacin^[35] 	<ul style="list-style-type: none"> hand hygiene.^[45]
<i>Legionella pneumophila</i>		<ul style="list-style-type: none"> Droplet contact, from e.g. cooling towers,^{[21][35]} humidifiers,^[21] air conditioners^{[21][35]} and water distribution systems^[21] 	<ul style="list-style-type: none"> Legionnaire's Disease^{[21][35]} Pontiac fever^{[21][35]} 	<ul style="list-style-type: none"> Macrolides, such as erythromycin^{[21][35]} Fluoroquinolones^[21] Rifampin^[35] 	(no vaccine or preventive drug) ^[21] Heating water ^[21]
<i>Leptospira</i> species		<ul style="list-style-type: none"> Food and water contaminated by urine from infected wild or domestic animals. <i>Leptospira</i> survives for weeks in fresh water and moist soil.^[21] 	<ul style="list-style-type: none"> Leptospirosis 	<ul style="list-style-type: none"> Penicillin G^[21] Tetracycline, e.g. doxycycline^[21] 	Vaccine not widely used ^[21] <ul style="list-style-type: none"> Doxycycline^[21] Prevention of exposure ^[21] <ul style="list-style-type: none"> Rodent control^[21]
<i>Listeria monocytogenes</i>		<ul style="list-style-type: none"> Raw milk or cheese,^{[21][35]} ground meats,^[21] poultry^[21] Vertically to newborn or fetus^{[21][35]} 	<ul style="list-style-type: none"> Listeriosis:^[21] <ul style="list-style-type: none"> Meningitis^[35] Sepsis^[35] 	<ul style="list-style-type: none"> Ampicillin^{[21][35]} Co-trimoxazole^{[21][35]} 	(no vaccine) ^[21] <ul style="list-style-type: none"> Proper food preparation and handling^[21]
<i>Mycobacterium</i>	<i>M. leprae</i>	<ul style="list-style-type: none"> Prolonged human-human contact, e.g. through exudates from skin lesions to abrasion of other person^[21] 	<ul style="list-style-type: none"> Leprosy (Hansen's disease)^[21] 	Tuberculoid form: <ul style="list-style-type: none"> Dapsone and rifampin^[21] Lepromatous form: <ul style="list-style-type: none"> Clofazimine^[21] 	<ul style="list-style-type: none"> BCG vaccine shows some effects^[21]
	<i>M. tuberculosis</i>	<ul style="list-style-type: none"> Droplet contact^[21] 	<ul style="list-style-type: none"> Tuberculosis 	(difficult, see Tuberculosis treatment for more details) ^[21]	<ul style="list-style-type: none"> BCG vaccine Isoniazid

				Standard "short" course: ^[21] <ul style="list-style-type: none"> First 2 months, combination: <ul style="list-style-type: none"> Isoniazid Rifampicin Pyrazinamide Ethambutol Further 4 months, combination: <ul style="list-style-type: none"> Isoniazid Rifampicin 	
<i>Mycoplasma pneumoniae</i>		<ul style="list-style-type: none"> Human flora^{[21][35]} Respiratory droplets^{[21][35]} 	<ul style="list-style-type: none"> Mycoplasma pneumonia^[21] 	<ul style="list-style-type: none"> Doxycycline and erythromycin^{[21][35]} 	
<i>Neisseria</i>	<i>N. gonorrhoeae</i>	<ul style="list-style-type: none"> Sexually transmitted^{[21][35]} vertical in birth^[21] 	<ul style="list-style-type: none"> Gonorrhea^{[21][35]} <ul style="list-style-type: none"> Urethritis (men)^[35] Pelvic inflammatory disease (women)^[35] Ophthalmia neonatorum^{[21][35]} Septic arthritis^{[21][35]} 	<p>Uncomplicated gonorrhea:^[21]</p> <ul style="list-style-type: none"> Ceftriaxone^[35] Tetracycline, e.g. doxycycline if also chlamydia is suspected^[35] Spectinomycin for resistance^{[21][35]} or patient allergy to cephalosporin^[21] <p>Ophthalmia neonatorum:</p> <ul style="list-style-type: none"> Erythromycin^{[21][35]} + ceftriaxone^[35] 	<p>(No vaccine)^[21]</p> <ul style="list-style-type: none"> Safe sex^[21] Erythromycin into eyes of newborn at risk^{[21][35]}
	<i>N. meningitidis</i>	<ul style="list-style-type: none"> Droplet transmission^[21] 	<ul style="list-style-type: none"> Meningococcal disease including meningitis^{[21][35]} Sepsis, including Waterhouse-Friderichsen syndrome^{[21][35]} 	<ul style="list-style-type: none"> Penicillin G^{[21][35]} Ceftriaxone^{[21][35]} 	<ul style="list-style-type: none"> NmVac4-A/C/Y/W-135 vaccine^{[21][35]} Rifampin^{[21][35]}
<i>Pseudomonas aeruginosa</i>	Opportunistic; ^[35] Infects damaged tissues or people with immunodeficiency. ^[21]	<p>Pseudomonas infection:^[21]</p> <ul style="list-style-type: none"> Pneumonia^{[21][35]} Urinary tract infection^{[21][35]} Corneal infection^{[21][35]} Endocarditis^{[21][35]} Osteomyelitis^{[21][35]} Burn wound infection^[35] Sepsis^{[21][35]} Malignant external otitis^[35] 	<ul style="list-style-type: none"> Anti-pseudomonal penicillins^[21] such as ticarcillin^[35] Aminoglycoside^[21] 	<p>(no vaccine)^[21]</p> <ul style="list-style-type: none"> Topical silver sulfadiazine for burn wounds^[21] 	
<i>Nocardia asteroides</i>	In soil ^[35]	Nocardiosis ^[35]	TMP/SMX ^[35]		
<i>Rickettsia rickettsii</i>	<ul style="list-style-type: none"> Wood or dog tick^{[21][35]} 	<ul style="list-style-type: none"> Rocky mountain spotted fever^{[21][35]} 	<ul style="list-style-type: none"> Doxycycline^{[21][35]} Chloramphenicol^{[21][35]} 	<p>(no preventive drug or approved vaccine)^[21]</p> <ul style="list-style-type: none"> Vector control, such as clothing^[21] Prompt removal of attached ticks^[21] 	
<i>Salmonella</i>	<i>S typhi</i>	<ul style="list-style-type: none"> Fecal-oral route, through food or water^{[21][35]} 	<ul style="list-style-type: none"> Typhoid fever type salmonellosis^[21] (fever, abdominal pain, hepatosplenomegaly, rose spots)^[35] Chronic carrier state^[35] 	<ul style="list-style-type: none"> Ceftriaxone^{[21][35]} Fluoroquinolones, e.g. ciprofloxacin^{[21][35]} 	<ul style="list-style-type: none"> Ty21a and ViCPS vaccines^[21] Hygiene and food preparation^[21]
	Other <i>Salmonella</i> species	<ul style="list-style-type: none"> Fecal-oral^[21] 			<p>(No vaccine or preventive drug)^[21]</p>

	e.g. <i>S. typhimurium</i> ^[21]	<ul style="list-style-type: none"> Food contaminated by fowl^[21] (e.g. uncooked eggs)^[35] or turtles^[35] 	<ul style="list-style-type: none"> Salmonellosis^[21] with gastroenteritis^{[21][35]} Paratyphoid fever^[35] Osteomyelitis in people with sickle cells^[35] Sepsis^[35] 	<ul style="list-style-type: none"> Fluid and electrolyte replacement for diarrhea^{[21][35]} Antibiotics (in neonates^[35] and immunocompromised^{[21][35]}): <ul style="list-style-type: none"> Ciprofloxacin^[35] Ceftriaxone^[35] TMP/SMX^[35] Azithromycin^[35] 	<ul style="list-style-type: none"> Proper sewage disposal^[21] Food preparation^[21] Good personal hygiene^[21]
<i>Shigella</i>	<i>S. sonnei</i> ^[21] <i>S. dysenteriae</i> ^[35]	<ul style="list-style-type: none"> Fecal-oral^{[21][35]} 	<ul style="list-style-type: none"> Shigellosis (bacillary dysentery) 	<ul style="list-style-type: none"> Fluid and electrolyte replacement^[35] Fluoroquinolone^[35] such as ciprofloxacin^[21] if severe^[35] 	<ul style="list-style-type: none"> Protection of water and food supplies^[21] Vaccines are in trial stage^[46]
<i>Staphylococcus</i>	<i>aureus</i>	<ul style="list-style-type: none"> Human flora on mucosae in e.g. anterior nares, skin and vagina,^{[21][35]} entering through wound 	<p>Coagulase-positive staphylococcal infections:</p> <ul style="list-style-type: none"> Skin infections, including impetigo^{[21][35]} Acute infective endocarditis^{[21][35]} Septis^{[21][21]} Necrotizing pneumonia^[21] Meningitis^[35] Osteomyelitis^[35] Toxinoses <ul style="list-style-type: none"> Scalded skin syndrome^{[21][35]} Toxic shock syndrome^{[21][35]} Staphylococcal food poisoning^{[21][35]} 	<ul style="list-style-type: none"> Incision and drainage of localized lesions^[21] Nafcillin,^{[21][35]} oxacillin,^[21] methicillin^[35] Vancomycin for Methicillin-resistant (MRSA)^[21] 	(no vaccine or preventive drug) <ul style="list-style-type: none"> Barrier precautions, washing hands and fomite disinfection in hospitals
	<i>epidermidis</i>	Human flora in skin, ^{[21][35]} anterior nares ^[21] and mucous membranes ^[35]	<ul style="list-style-type: none"> Infections of implanted prostheses (e.g. heart valves^[21] and joints^[35]) and catheters^{[21][35]} 	<ul style="list-style-type: none"> Vancomycin^{[21][35]} 	None ^[21]
	<i>saprophyticus</i>	Part of normal vaginal flora ^[21]	<ul style="list-style-type: none"> Cystitis in women^{[21][35]} 	<ul style="list-style-type: none"> TMP/SMX or norfloxacin^[47] 	None ^[21]
<i>Streptococcus</i>	<i>agalactiae</i>	Human flora in vagina, ^{[21][35]} urethral mucous membranes, ^[21] rectum ^[21] <ul style="list-style-type: none"> Vertically during childbirth^[21] Sexually^[21] 	<ul style="list-style-type: none"> Neonatal meningitis^{[21][35]} Neonatal sepsis^{[21][35]} Neonatal pneumonia^[35] Endometritis in postpartum women^[21] Opportunistic infections with septicemia and pneumonia^[21] 	<ul style="list-style-type: none"> Penicillin G^{[21][35]} Aminoglycoside in case of lethal infection^[21] 	None ^[21]
	<i>pneumoniae</i>	<ul style="list-style-type: none"> Respiratory droplets Human flora in nasopharynx^[35] (spreading in immunocompromised)^[21] 	<ul style="list-style-type: none"> Acute bacterial pneumonia & meningitis in adults^{[21][35]} Otitis media and sinusitis in children^{[21][35]} Sepsis^[35] 	<ul style="list-style-type: none"> Penicillin G^{[21][35]} 	<ul style="list-style-type: none"> 23-serotype vaccine for adults (PPV)^{[21][35]} Heptavalent conjugated vaccine for children (PCV)^[21]
	<i>pyogenes</i>				No vaccine ^[21]

		<ul style="list-style-type: none"> Respiratory droplets^[21] Direct physical contact with impetigo lesions^[21] 	<ul style="list-style-type: none"> Streptococcal pharyngitis^{[21][35]} Sepsis^[35] Scarlet fever^{[21][35]} Rheumatic fever^{[21][35]} Impetigo and erysipelas^{[21][35]} Puerperal fever^[21] Necrotizing fasciitis^[21] Poststreptococcal glomerulonephritis^[35] 	<ul style="list-style-type: none"> Penicillin G^{[21][35]} or V^[35] Macrolide, e.g. clarithromycin^[21] or erythromycin^[35] in penicillin allergy Drainage and debridement for necrotizing fasciitis^[21] 	<ul style="list-style-type: none"> Rapid antibiotic treatment helps prevent rheumatic fever^[21]
	<i>viridans</i>	Oral flora, ^[35] penetration through abrasions	<ul style="list-style-type: none"> Subacute bacterial endocarditis^[35] Dental cavities^[35] Abscesses of brain and liver^[35] 	Penicillin G ^[35]	
	<i>Treponema pallidum</i>	<ul style="list-style-type: none"> Sexual^{[21][35]} 	<ul style="list-style-type: none"> Syphilis^{[21][35]} Congenital syphilis^{[21][35]} 	<ul style="list-style-type: none"> Penicillin G^{[21][35]} Doxycycline if penicillin allergy^{[21][35]} 	<ul style="list-style-type: none"> No preventive drug or vaccine^[21] Safe sex^[21] Antibiotics to pregnant women if risk of transmitting to child^[21]
	<i>Vibrio cholerae</i>	<ul style="list-style-type: none"> Fecal-oral route^[35] Contaminated water and raw seafood^[21] 	<ul style="list-style-type: none"> Cholera: Severe "rice water" diarrhea^[35] 	<ul style="list-style-type: none"> Fluid^[35] and electrolyte replacement^[21] Doxycycline^{[21][35]} 	<ul style="list-style-type: none"> Proper sanitation^[21] Adequate food preparation^[21]
	<i>Yersinia pestis</i>	<ul style="list-style-type: none"> Fleas from animals^{[21][48]} Ingestion of animal tissues^[21] Respiratory droplets^[21] 	<p>Plague:</p> <ul style="list-style-type: none"> Bubonic plague Pneumonic plague 	<ul style="list-style-type: none"> Streptomycin primarily^{[21][49][50]} Tetracyclin^{[21][51]} Supportive therapy for shock^[21] 	<ul style="list-style-type: none"> Plague vaccine^[52] Minimize exposure to rodents and fleas^[21]

See also

- Human microbiome project
- List of antibiotics
- Pathogenic viruses

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External links

- Bacterial Pathogen Pronunciation (<http://www.atsu.edu/faculty/chamberlain/Website/studio.htm>) by Neal R. Chamberlain, Ph.D at A.T. Still University
- *Raw Living Radio Interviews Dr Robert Cassar as part of a 3 Show Series in HD 2014* (https://www.youtube.com/playlist?list=PL2EBTATY1S1_HTFtL0qrGOqweeiUoXnCr) from the EarthShiftProject.com (<https://www.youtube.com/EarthShiftProject>) an Educational and Informational Research Organization welcoming More participation from fellow Student Researchers, ...We want to Include More Student Researchers Including You!]
- Pathogenic bacteria (<http://patricbrc.org>) genomes and related information at PATRIC (<http://patricbrc.org/>), a Bioinformatics Resource Center funded by NIAID (<https://www.niaid.nih.gov/>)

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