

Complete Summary of Bacterial Types and Key Information

Bacillus anthracis

Description: Causes Anthrax (cutaneous, inhalation, gastrointestinal). Found in soil and infected animals. Produces edema toxin and lethal toxin.

Key Features: Gram-positive, spore-forming, aerobic, potential bioterrorism agent.

Clinical Presentation: Skin ulcers (necrotic eschar), respiratory distress, gastrointestinal symptoms.

Bacillus cereus

Description: Causes food poisoning (emetic and diarrheal forms). Also responsible for eye infections.

Key Features: Gram-positive, spore-forming, widespread in the environment.

Clinical Presentation: Vomiting (emetic form, from rice), diarrhea (from meat/vegetables), eye trauma infections.

Clostridium difficile

Description: Causes pseudomembranous colitis and severe diarrhea, usually after antibiotic use.

Key Features: Gram-positive, spore-forming, anaerobic, produces toxins A and B.

Clinical Presentation: Severe diarrhea, abdominal pain, yellow-white plaques in colon (pseudomembranes).

Clostridium perfringens

Description: Causes gas gangrene (myonecrosis), cellulitis, and food poisoning.

Key Features: Gram-positive, spore-forming, anaerobic, produces alpha toxin and enterotoxins.

Clinical Presentation: Tissue infections with gas formation, abdominal cramps (food poisoning).

Clostridium tetani

Description: Causes tetanus due to tetanospasmin toxin.

Key Features: Gram-positive, spore-forming, anaerobic, found in soil.

Clinical Presentation: Lockjaw (trismus), spastic paralysis, sardonic smile, respiratory failure.

Clostridium botulinum

Description: Causes botulism (foodborne, infant, wound) due to neurotoxin production.

Key Features: Gram-positive, spore-forming, anaerobic, produces botulinum toxin types A, B, E, F.

Clinical Presentation: Flaccid paralysis, respiratory failure, infant hypotonia (floppy baby syndrome).

Enterotoxigenic E. coli (ETEC)

Description: Major cause of bacterial diarrheal disease in developing countries and responsible for 30% of traveler's diarrhea.

Key Features: Transmitted through contaminated food or water; does not spread person-to-person.

Clinical Presentation: Watery, non-bloody diarrhea, abdominal cramps, nausea, and vomiting. Can be fatal in undernourished individuals.

Toxins: Produces heat-stable toxin (increases cGMP, causing fluid secretion) and heat-labile toxin (increases cAMP, enhancing chloride secretion).

Shiga toxin-producing E. coli (STEC)

Description: Infections linked to undercooked meat, unpasteurized products, and uncooked produce.

Highly infectious (fewer than 100 bacteria).

Key Features: Can spread person-to-person. Includes strains like STEC O157:H7, which are more severe.

Clinical Presentation: Ranges from mild diarrhea to bloody diarrhea and hemorrhagic colitis. Can lead to hemolytic uremic syndrome (HUS), especially in children.

Complications: HUS involves acute renal failure, thrombocytopenia, and hemolytic anemia.

Escherichia coli/Extraintestinal Infections

Description: E. coli is a common cause of UTIs, neonatal meningitis, and septicemia.

Key Features: Responsible for 80% of UTIs, often ascending from the colon. Affects women more frequently due to anatomical differences.

Clinical Presentation: UTIs: Dysuria and cystitis; Neonatal meningitis: CNS infections in infants under 1 month; Septicemia: Originates from GI or urinary infections.

Salmonella

Description: Can colonize most animals, especially poultry. Some serotypes (e.g., *Salmonella* Typhi and Paratyphi) are human-adapted.

Key Features: Virulence depends on pathogenicity islands encoding for toxins, attachment proteins, and immune evasion mechanisms.

Clinical Presentation: Gastroenteritis: Nausea, vomiting, non-bloody diarrhea; Typhoid fever: Gradual fever, headache, myalgias, anorexia.

Transmission: Ingestion of contaminated poultry, eggs, or water. Person-to-person spread possible for *Salmonella* Typhi.

Shigella

Description: Four species: *S. dysenteriae*, *S. flexneri*, *S. boydii*, *S. sonnei*. Invades and replicates in colonic cells.

Key Features: Produces Shiga toxin (*S. dysenteriae*), disrupts protein synthesis, and causes renal failure (HUS) in severe cases.

Clinical Presentation: Abdominal cramps, diarrhea, fever, and bloody stools; primarily affects children under 10 years.

Transmission: Fecal-oral route, requiring only 100-200 bacteria to establish infection. Rapid spread in poor hygiene conditions.

Klebsiella

Description: Normal flora in the human nose, mouth, and gastrointestinal tract. Most commonly isolated species is *K. pneumoniae*.

Key Features: Can cause pneumonia (community- or hospital-acquired), UTIs, and wound infections. Colonizes hospital environments and spreads nosocomial infections.

Clinical Presentation: Primary lobar pneumonia, wound infections, urinary tract infections.

Proteus

Description: Most common species is *P. mirabilis*, primarily causing urinary tract infections.

Key Features: Produces urease, splitting urea into carbon dioxide and ammonia, raising urine pH and forming kidney stones.

Clinical Presentation: UTIs, formation of renal stones due to struvite and apatite crystal precipitation.

Yersinia

Description: The best-known pathogen is *Y. pestis*, responsible for bubonic and pneumonic plague.

Key Features: Zoonotic infections; urban plague (rats as reservoirs) and sylvatic plague (squirrels, rabbits, etc.).

Clinical Presentation: Bubonic plague: Fever, painful bubo (lymph node swelling), bacteremia.

Pneumonic plague: Aerosol spread, highly infectious.

Carbapenem-resistant Enterobacteriaceae (CRE)

Description: Gram-negative bacteria resistant to carbapenem antibiotics, considered last-resort drugs.

Key Features: Produce carbapenemase enzyme, disabling drug molecules. Known as a 'superbug' due to high mortality rates.

Clinical Presentation: Bloodstream infections with up to 50% mortality, especially in healthcare-exposed patients.

Actinomyces

Description: Facultatively anaerobic or strictly anaerobic gram-positive rods that grow slowly and cause chronic infections.

Key Features: Colonize upper respiratory, gastrointestinal, and female genital tracts; infections are endogenous with no person-to-person spread.

Clinical Presentation: Chronic granulomatous lesions with abscesses and sinus tracts. Commonly

cervicofacial, abdominopelvic, and thoracic infections.

Treatment: Drainage of abscesses, surgical debridement, and prolonged antibiotic therapy.

Nocardia

Description: Gram-positive, filamentous bacteria causing chronic infections. Virulence relies on avoiding phagocytic killing.

Key Features: Produces catalase and superoxide dismutase to neutralize phagocytic cells. Prevents phagosome-lysosome fusion and acidification.

Clinical Presentation: Bronchopulmonary disease (mostly in immunocompromised patients), primary cutaneous nocardiosis (after trauma), and brain abscesses (dissemination in 1/3 of cases).

Unique Features: Mycetoma: Painless subcutaneous mass, multiple sinuses, and discharge containing grains. Can lead to amputation in late presentations.

Lactobacillus

Description: Facultatively or strictly anaerobic rods that produce lactic acid. Found in normal flora and probiotics.

Key Features: Dominant in the female genital tract in 70% of women. Rarely causes infections but plays a role in food fermentation (e.g., yogurt, cheese).

Clinical Presentation: Transient bacteremia (after childbirth or procedures), endocarditis, or opportunistic septicemia in immunocompromised patients.

Unique Features: Commonly used in probiotics and industrial fermentation processes (yogurt, cheese, pickles).

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Comprehensive Bacterial Summary

Propionibacterium (Cutibacterium acnes)

Description: Small gram-positive rods, commonly found on the skin, conjunctiva, external ear, oropharynx, and female genital tract.

Key Features: Most commonly isolated species is *P. acnes* (renamed *Cutibacterium acnes*). Triggers acne vulgaris in teenagers and young adults and causes opportunistic infections in patients with prosthetic devices or intravascular lines.

Clinical Presentation: Acne vulgaris: Triggers the disease under favorable dermatophysiological conditions. Opportunistic infections: Associated with medical devices.

Mobiluncus

Description: Obligate anaerobic, gram-variable or gram-negative, curved rods with tapered ends. Classified as gram-positive due to cell wall characteristics.

Key Features: Lack endotoxin and are susceptible to antibiotics like vancomycin, clindamycin, erythromycin, and ampicillin but resistant to colistin.

Clinical Presentation: Rarely found in healthy vaginas but abundant in women with bacterial vaginosis (e.g., *M. curtisii*).

Bifidobacterium and Eubacterium

Description: Commonly found in the oropharynx, large intestine, and vagina. Usually represent clinically insignificant contaminants.

Key Features: Non-spore-forming anaerobic gram-positive rods.

Clinical Presentation: Typically harmless and rarely associated with significant infections.

Non-spore forming Aerobic Gram-Positive Rods

Description: A heterogeneous group of bacteria including well-recognized pathogens (e.g., *Listeria monocytogenes*, *Corynebacterium diphtheriae*), animal pathogens causing human disease (e.g.,

Erysipelothrix rhusiopathiae), and opportunistic pathogens infecting immunocompromised patients (e.g., *Corynebacterium jeikeium*).

Key Features: Gram-positive rods without spore formation. Includes facultative and obligate anaerobes.

Clinical Presentation: Varies by species, ranging from localized infections to systemic disease.

Listeria monocytogenes

Description: Short, gram-positive, facultatively anaerobic rods that exhibit weak beta-hemolysis on blood agar. Motile at room temperature with a characteristic tumbling motion.

Key Features: Facultative intracellular pathogen. Replicates in macrophages and spreads cell-to-cell using actin polymerization.

Clinical Presentation: Foodborne listeriosis: Mild flu-like symptoms in healthy adults, severe disease in neonates, elderly, and immunocompromised patients. Neonatal infections: Early-onset (in utero, leading to abortion or stillbirth) and late-onset (2-3 weeks post-birth, causing meningitis).

Transmission: Primarily through contaminated food. Human-to-human transmission occurs mother-to-child during pregnancy or delivery.

Corynebacterium diphtheriae and Anaerobic Gram-Positive Cocci

Corynebacterium diphtheriae

Description: Irregularly staining, pleomorphic rod. Aerobic or facultatively anaerobic, nonmotile, catalase positive, and colonizes skin, respiratory tract, and gastrointestinal tract in humans.

Key Features: Etiologic agent of diphtheria. Humans are the only known reservoir. Transmitted via respiratory droplets or skin contact.

Clinical Presentation: Respiratory diphtheria: Sudden onset with sore throat, exudative pharyngitis, low-grade fever, and formation of a thick pseudomembrane that can block the airways.

Virulence: Diphtheria toxin: A-B exotoxin. A subunit inhibits protein synthesis by ADP-ribosylating eEF-2, leading to cell death.

Anaerobic Gram-Positive Cocci

Description: Normally colonize the oral cavity, gastrointestinal tract, genitourinary tract, and skin.

Cause infections when spreading to sterile sites.

Key Features: Peptostreptococcus species are most commonly recovered from subcutaneous and soft tissue abscesses, diabetic foot ulcers, and chronic infections.

Clinical Presentation: Infections often synergistic, involving multiple bacterial species. Chronic infections are common.

Campylobacter and Helicobacter pylori Summaries

Campylobacter

Description: Small, motile, curved gram-negative rods. Microaerophilic (requires reduced oxygen and increased carbon dioxide) with optimal growth at 42°C. Sensitive to gastric acids, with infection favored by reduced gastric acid secretion.

Epidemiology: Zoonotic transmission, primarily from poultry (over 50% of cases). Rarely transmitted via food handlers.

Clinical Presentation: Acute enteritis with diarrhea (often bloody), fever, and severe abdominal pain.

Rare complications include Guillain-Barré Syndrome and reactive arthritis.

Diagnosis: Presumptive identification based on growth in selective conditions, positive oxidase and catalase tests, and microscopic morphology.

Complications: Associated with Guillain-Barré Syndrome and reactive arthritis. Causes histologic damage to the jejunum.

Helicobacter pylori

Description: Spiral, motile gram-negative rods resembling Campylobacter. Produces urease to neutralize stomach acid and adapts to gastric conditions. Highly motile with a corkscrew motion.

Pathogenesis: Colonizes gastric mucosa and persists for life unless treated. Mechanisms include urease byproducts, mucinase, phospholipases, VacA toxin (vacuole formation), and CagA gene (interferes with cytoskeletal structure).

Clinical Presentation: Acute gastritis: Fullness, nausea, vomiting, and hypochlorhydria. Chronic gastritis can lead to peptic ulcers (gastric or duodenal). Associated with 85% of gastric ulcers, 95% of duodenal ulcers, gastric cancer, and MALT lymphoma.

Diagnosis: Histologic detection in biopsy specimens or non-invasive immunoassays for stool antigens (sensitivity >95%).

Transmission: Transmitted via fecal-oral route. Humans are the primary reservoir.

Vibrio Summary

Vibrio

Description: Gram-negative, facultatively anaerobic, fermentative rods with polar flagella. Oxidase positive and halophilic ('salt-loving'), requiring sodium chloride (NaCl) for growth. Grow at a wide temperature range (14 to 40 degrees Celsius) and tolerate pH 6.5 to 9.0 but are susceptible to stomach acids.

Epidemiology: Naturally found in estuarine and marine environments, often associated with shellfish. *V. cholerae* O1 and O139 serogroups produce cholera toxin and cause cholera epidemics. Spread through contaminated water and food; requires a high inoculum for infection.

Pathogenesis: Cholera toxin (A-B toxin): Stimulates adenylate cyclase via G proteins, increasing cAMP and causing hypersecretion of water and electrolytes. Virulence factors include toxin co-regulated pilus (TCP) and bacteriophage integration that encodes cholera toxin genes.

Clinical Presentation: Abrupt onset of watery diarrhea and vomiting after 2-3 days of ingestion (can be as early as 12 hours). 'Rice-water' stools: Colorless, odorless, mucus-filled. Severe cases lead to dehydration, hypovolemic shock, and metabolic acidosis. Asymptomatic or self-limited diarrhea in most cases.

Complications: Severe fluid and electrolyte loss can cause muscle cramps, cardiac arrhythmia, renal failure, and death. Mortality rate is 70% in untreated cases but less than 1% with proper fluid and electrolyte replacement.

Diagnosis: Detection of cholera toxin or O1/O139 lipopolysaccharides using immunoassays in endemic areas.

Treatment: Immediate fluid and electrolyte replacement. Antibiotics may reduce the duration and severity of symptoms but are secondary to rehydration.

Key Points: Cholera is common in areas with poor sanitation. Preventable with clean water, proper sanitation, and rapid treatment in outbreaks.

Mycoplasma and Aggregatibacter Summary

Mycoplasma

- Smallest free-living bacteria, lacking a cell wall; membrane contains sterols.
- Pleomorphic shapes: 0.2-0.3 micrometers coccoid forms to 1-2 micrometers rods.
- *M. pneumoniae*: Strict human pathogen causing tracheobronchitis and primary atypical pneumonia.
- *M. genitalium*: Causes nongonococcal urethritis (NGU) and pelvic inflammatory disease.
- Diagnosis: PCR amplification is the most sensitive method. Poor Gram staining.
- Resistance: No cell wall, resistant to penicillins, cephalosporins, and vancomycin.

Aggregatibacter

- Two key species: *A. actinomycetemcomitans* and *A. aphrophilus*.
- *A. actinomycetemcomitans*: Associated with localized aggressive periodontitis.
- Both species colonize the human mouth and can spread to blood, leading to endocarditis on damaged or artificial valves.
- Gram-negative, facultative anaerobe, and non-motile.

Bacteria Summaries

Pseudomonas

- Gram-negative, motile rods with a broad environmental distribution (soil, water, hospital).
- Produces blue-green pigment (pyocyanin) and has a distinctive fruity odor.
- Opportunistic pathogen causing pulmonary infections, skin infections (e.g., burn wounds), UTIs, and ear infections ('swimmer's ear').
- Resistant to many antibiotics due to efflux pumps and low permeability outer membrane.

Moraxella

- *M. catarrhalis* is a strictly aerobic, oxidase-positive, gram-negative diplococcus.
- Common cause of upper respiratory tract infections in children and lower respiratory infections in adults with COPD.
- Considered a nosocomial pathogen.

Legionella

- Slender, pleomorphic, gram-negative rods found in moist environments (e.g., water systems).
- Facultative intracellular bacteria infecting macrophages; causes robust inflammatory response.
- *L. pneumophila* causes Pontiac fever (self-limited) and Legionnaires' disease (severe pneumonia).
- Diagnosed using BCYE agar for culture.

Bordetella

- Small, gram-negative coccobacillus; causes pertussis (whooping cough).
- Pertussis toxin increases cAMP, leading to respiratory secretions and mucus production.
- Vaccination significantly reduced incidence; spread by respiratory droplets.

Haemophilus

- Small, gram-negative rods requiring X (hemin) and V (NAD) factors for growth.
- *H. influenzae* type b is encapsulated and a major cause of meningitis, epiglottitis, and cellulitis in

unvaccinated children.

- Nonencapsulated strains cause otitis media, sinusitis, and respiratory infections.
- Vaccination has drastically reduced invasive *H. influenzae* type b infections.

Summary of Spirochetes, Borrelia, and Rickettsiaceae

Spirochetes (General)

- Long, helical (corkscrew-shaped) gram-negative bacteria with a double membrane.
- Key Pathogens: *Treponema pallidum* (Syphilis), *Borrelia* species (Lyme disease, relapsing fever).

Treponema pallidum (Syphilis)

- Thin, helical bacteria (0.1-0.5 x 5-20 micrometers).
- Cannot be cultured in vitro; highly dependent on host cells for survival.
- Diagnosed using darkfield microscopy, immunofluorescence, or serological tests (nontreponemal for screening; treponemal for confirmation).
- Transmission: Sexual contact, congenital transmission, or contaminated blood transfusion.
- Clinical Phases: Primary (chancres), Secondary (disseminated lesions, fever), Tertiary (organ damage, neurosyphilis).
- Prevention: Safe-sex practices and antibiotic treatment.

Borrelia

- Larger spirochetes (0.2-0.5 x 8-30 micrometers).
- Stain well with Giemsa but poorly with Gram stain.
- Diagnosis via serology or microscopy as culture is usually unsuccessful.
- Diseases: Lyme Disease (transmitted by hard ticks) and Relapsing Fever (transmitted by lice or soft ticks).
- Tick-Borne Diseases: Ticks can transmit multiple pathogens, complicating diagnosis and treatment.

Rickettsiaceae

- Obligate intracellular, aerobic gram-negative rods.
- Seen best with Giemsa stain.

- Diseases: Spotted Fever Group (most common travel-associated infection) and Typhus Group (epidemic typhus by *R. prowazekii*).
- Pathogenesis: Infect endothelial cells, causing vascular damage and blood leakage.
- Transmission: Ectoparasites (ticks, fleas, lice, mites). Geographic distribution matches vector distribution.

Bartonella and Chlamydia Summary

Bartonella

- Gram-negative, coccobacillary or bacillary rods with fastidious growth (2-6 weeks).
- Facultative intracellular bacteria transmitted by vectors (ticks, fleas, sand flies, mosquitoes).
- *B. henselae* causes cat-scratch disease after exposure to cats (scratches, bites, flea feces).
- Symptoms: Non-painful bump or blister at injury site and painful, swollen lymph nodes.

Chlamydia

- Obligate intracellular parasites using host ATP; possess bacterial properties (e.g., membranes, DNA/RNA, ribosomes).
- Unique life cycle: Infectious elementary bodies (EBs) and metabolically active reticulate bodies (RBs).
- Infect epithelial cells of mucous membranes (e.g., urethra, endocervix, respiratory tract, conjunctiva).
- Leading cause of bacterial sexually transmitted diseases and infectious blindness (trachoma).
- Diagnosis: Cytologic, serologic, culture findings, antigen detection, or nucleic acid-based tests.

Chlamydia - Clinical Picture

- Trachoma: Leading cause of preventable blindness, transmitted via droplets, hands, clothing, and flies.
- Most genital tract infections in women are asymptomatic (80%); in men, most are symptomatic (75%).
- Causes cervicitis in women and urethritis and proctitis in both men and women.