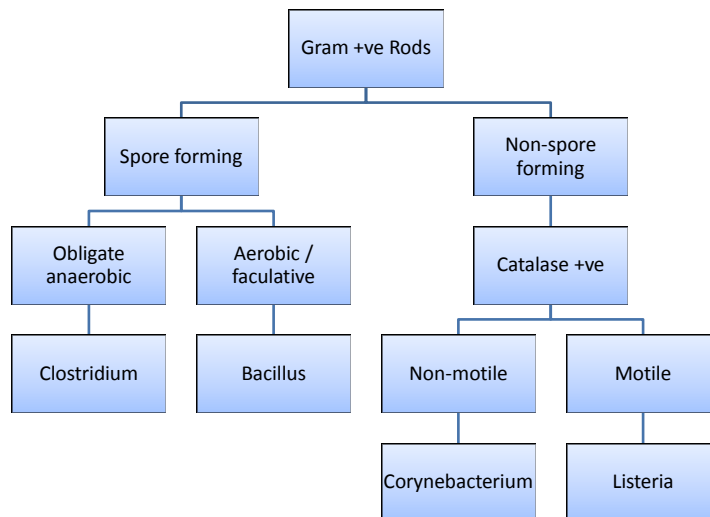


Gram Positive Rods

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Listeria

- Most medically important is *Listeria monocytogenes*
- *L. monocytogenes* is intracellular pathogen that doesn't produce capsules or spores but it is resistant to cold (can grow at temperatures as low as 0°C), salt, pH extremes, and bile salts
- Causes listeriosis; which is usually a mild or subclinical infection in healthy adults but often serious in fetuses, neonates and immunocompromised patients (mainly causes meningitis, endocarditis and gastroenteritis in these groups)
- Although *L. monocytogenes* is widely spread in the environment, most cases of listeriosis are associated with ingesting contaminated dairy products, poultry and meat
- Listeriosis can be prevented by pasteurization of dairy products and proper washing, storage and cooking of foods
- Most strains are still susceptible to penicillins and macrolides

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Corynebacterium

- Irregularly shaped bacilli that stains unevenly (looks like Chinese letters under microscope)
- Includes many species; most of which are non-pathogenic normal flora (called diphtheroids), however *Corynebacterium diphtheriae* is a highly infectious human pathogen
- *C. diphtheriae* is mainly transmitted by respiratory droplets and can cause upper respiratory tract infection (diphtheria) with serious systemic complications affecting the heart, motor neurons and adrenal glands
- Most harmful effects of *C. diphtheriae* is caused by its powerful toxin (diphtheria toxin) which is only produced by some lysogenic strains and can inhibit protein biosynthesis in host cells leading to their death

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Corynebacterium

- Diphtheria has high mortality rate especially in children and the elderly
- *C. diphtheriae* is best grown on blood tellurite agar
- Highly effective vaccine is available, which is a toxoid that is usually given as part of the DTaP vaccine (in Jordan it is given at 2,3,4 and 18 months)
- Treatment of diphtheria involves the use of antibiotics (mainly penicillins and macrolides) as well as the neutralization of the toxin by horse or human antitoxin sera

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Bacillus

- Bacillus species are Gram +ve bacilli
- Under harsh environmental conditions they form endospores which can survive for long time. Spores are highly resistant to dryness, temperature and chemical antimicrobials.
- While Bacillus spp. Are widely spread in nature (i.e. soil, vegetation, water and animal/human intestines) only few of them are pathogenic to humans. Most medically important are *B. cereus* and *B. anthracis*

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Bacillus

- *Bacillus cereus*
 - *B. cereus* is a common food contaminant (i.e. **rice**, meat, fish and dairy products), in which it can survive, vegetate and produce a heat-stable **enterotoxin**
 - Ingestion of toxin-contaminated food results in food poisoning that usually causes vomiting and diarrhea
 - Incubation period is up to 16 hours
 - Usually self-limiting; no need for antibiotics (usually rest and fluid replacement only)

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Bacillus

- *Bacillus anthracis*
 - *B. anthracis* has a proteinaceous capsule and produces powerful toxins that induce edema, tissue damage and hemorrhage; most important are:
 - Edema factor
 - Lethal factor
 - Protective antigen: protects edema and lethal factors from body's proteases. Also induces protective antibodies when used as a vaccine
 - *B. anthracis* causes anthrax which is a zoonotic disease that mainly affects people who handle animal wool or hair. It mainly manifests as either cutaneous anthrax or pulmonary anthrax
 - Spores of *B. anthracis* are also used as warfare agent (biological weapon)

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Bacillus

- *Bacillus anthracis*
 - Cutaneous anthrax:
 - When spores become in contact with human skin, they vegetate and cause swollen, necrotic and hemorrhagic lesions (malignant pustules)
 - Not normally fatal
 - Pulmonary anthrax:
 - When spores are inhaled, they travel to lymph nodes in the chest where they vegetate and produce toxins
 - Hemorrhagic fluid accumulate in the lungs and the bacteria (and its toxins) can disseminate into the blood causing septic shock
 - Highly fatal
 - Diagnosis involves Gram staining and culture (on blood agar) of skin, blood or sputum specimens
 - *B. anthracis* is usually susceptible to many antibiotics including penicillins, tetracyclines and fluoroquinolones

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Clostridia

- Clostridium bacteria are obligate anaerobic spore-forming Gram +ve bacilli that include many medically important species
- Common in the environment (i.e. soil) and human/animal intestines
- They produce a range of potent exotoxins
- Source of Clostridium infections can be exogenous or endogenous

Clostridia

- *Clostridium tetani* (tetanus)
 - Common resident of cultivated soil and the GIT of animals
 - In tetanus, spores usually enter the body through accidental puncture wounds where they germinate and release powerful neurotoxin (**tetanospasmin**) that enters motor nerve endings and travels in axons to CNS
 - Tetanospasmin inhibits muscle relaxation resulting in **spastic paralysis** that begins in the jaw and then progresses to the rest of the body (fatal if not treated)
 - Incubation period 4-10 days
 - Toxoid vaccine is available (part of DTaP)
 - Treatment involves surgical debridement, antibiotics (penicillin or tetracycline) and toxoid vaccine (antitoxin serum may also be used)

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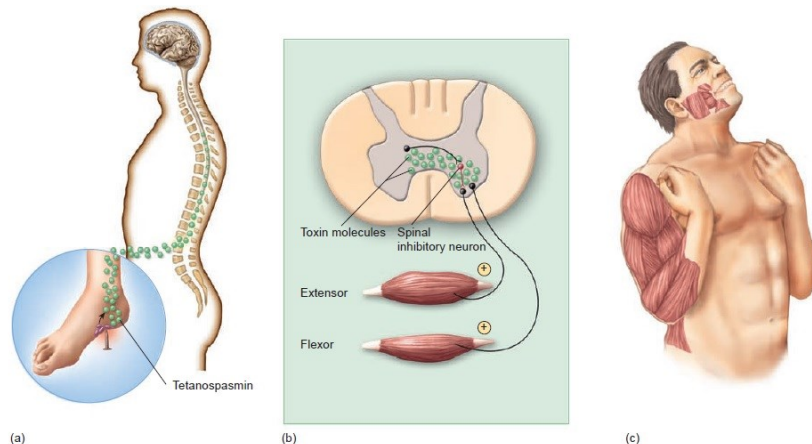


Figure 19.22 The events in tetanus. (a) After traumatic injury, bacteria infecting the local tissues secrete tetanospasmin, which is absorbed by the peripheral axons and is carried to the target neurons in the spinal column. (b) In the spinal cord, the toxin attaches to the junctions of regulatory neurons that inhibit inappropriate contraction. Released from inhibition, the muscles, even opposing members of a muscle group, receive constant stimuli and contract uncontrollably. (c) Muscles contract spasmodically, without regard to regulatory mechanisms or conscious control. Note the clenched jaw typical of risus sardonicus.

Clostridia

- *Clostridium botulinum* (botulism)
 - Botulism is an intoxication with botulinum toxin caused by the ingestion of preformed toxin (food-borne botulism) or infection by *C. botulinum* (infant botulism and wound botulism)
 - *C. botulinum* commonly inhabits soil, water and intestinal tract of animals but most common source is intoxication is improperly prepared canned food
 - Botulinum toxin is a heat stable exotoxin and is considered the most potent toxin known to man
 - Botulinum toxin prevents the release acetylcholine in neuromuscular junctions causing **flaccid paralysis**

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Clostridia

- *Clostridium botulinum* (botulism)
 - Onset of symptoms takes 12 to 72 hours, depending on the size of the toxin dose
 - Most patients die as a result of respiratory arrest
 - Vaccine is available but not commonly used because it is associated with significant side effects
 - Treatment involves horse antitoxin serum and respiratory/cardiac supportive care

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Clostridia

- *Clostridium perfringens*
 - Produces wide range of toxins including α -toxin (phospholipase C), collagenase and hyaluronidase
 - It contaminates deep wounds where it causes tissue necrosis (mainly myonecrosis) creating anaerobic environment suitable for its further growth and spreading
 - Infected area characterized by discolored blood and gas production → **gas gangrene**
 - Treatment involves surgical debridement/ limb amputation and antibiotics (high dose penicillin)
 - *C. perfringens* also causes food poisoning where its enterotoxin produces intense watery diarrhea

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Clostridia

- *Clostridium difficile*
 - Normal flora in GIT, but usually kept in low numbers. When using antibiotics for long periods (especially lincosamides, broad spectrum penicillins and cephalosporins) it grows in high numbers and produces two toxins (toxin A and toxin B) causing severe bloody diarrhea → pseudomembranous colitis (superinfection)
 - Treatment: stop used antibiotic and replace with oral metronidazole or vancomycin

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