

Spore-Forming Gram-Positive Bacilli: *Clostridium* Species

The clostridia are large anaerobic, Gram-positive, motile spore-forming rods and because they form spores, they can survive in the environment for many years. Their natural habitat is the soil, marine sediments, sewage, where they live as saprophytes, or the intestinal tract of animals and humans as a normal flora.

Clostridia cause several important toxin-mediated diseases, including tetanus (*Clostridium tetani*), botulism (*C. botulinum*), gas gangrene (*C. perfringens*), and antibiotic-associated diarrhea and pseudomembranous colitis (*C. difficile*).

Morphology and Identification

Typical Organisms

Spores of clostridia are usually wider than the diameter of the rods in which they are formed, they are placed centrally, sub-terminally, or terminally. Most species of clostridia are motile and possess peritrichous flagella. Members of this genus produce potent toxins.

1. *Clostridium tetani*

Disease

Clostridium tetani causes tetanus. Spores are widespread in soil, *C. tetani* produces a **terminal spore** (a spore at the end of the rod). This gives the organism the characteristic appearance of a “tennis racket”.

Transmission

The portal of entry is usually a deep **wound** site because *C. tetani* cannot grow in the presence of oxygen, such as wounds from a puncture or contaminated needle injection **or** where a nail penetrates the foot, the

combination of tissue death and limited exposure to surface air can result in a very low-oxygen environment, allowing *C. tetani* spores to germinate and grow. Germination of spores is favored by necrotic tissue and poor blood supply in the deep wound.

Pathogenesis

As *C. tetani* grows at the wound site, it releases the tetanus toxins **tetanospasmin** is one of the most potent toxins known that produced by vegetative cells at the wound site, with an estimated lethal dose less than 2.5 nanograms per kilogram of body weight, and is responsible for the symptoms of tetanus. This type of toxins work on central nervous system, which spreads via the lymphatic system and bloodstream throughout the body, where it is taken up into various parts of the nervous system.

Clinical Findings

Tetanus is characterized by strong muscle spasms (spastic paralysis, tetany). Specific clinical features include **lockjaw** due to rigid contraction of the jaw muscles, which prevents the mouth from opening. Respiratory failure ensues. A high mortality rate is associated with this disease.

2. Clostridium botulinum

Disease

Clostridium botulinum causes botulism. Spores of the organism are highly resistant to heat, withstanding 100°C for several hours, occupy sub-terminal position in bacterial cells.

Transmission

Spores, widespread in soil, contaminate vegetables and meats. When these foods are canned or vacuum-packed without adequate sterilization, spores survive and germinate in the anaerobic environment. Toxin is produced within the canned food.

Pathogenesis

Botulinum toxin is absorbed from the gut and carried via the blood to peripheral nerve synapses, where it blocks release of acetylcholine.

Clinical Findings

Descending weakness and paralysis, respiratory muscle failure.

3. *Clostridium perfringens*

Clostridium perfringens causes two distinct diseases, gas gangrene and food poisoning, depending on the route of entry into the body.

Disease: Gas Gangrene

Transmission

Gas gangrene is associated with war wounds, automobile and motorcycle accidents, where the spores or vegetative cells are located in the soil, and have the ability to cause contamination, then can develop the disease.

Pathogenesis

Organisms grow in traumatized tissue (especially muscle) and produce a variety of toxins. The most important is **alpha toxin** (lecithinase), which damages cell membranes, including those of

erythrocytes, resulting in hemolysis. Degradative enzymes produce gas in tissues.

Clinical Findings

Pain, edema, cellulitis, and gangrene (necrosis) occur in the wound area. If crepitus is palpated in the affected tissue, it indicates gas in the tissue. This gas is typically hydrogen produced by the anaerobic bacteria.

4. *Clostridium difficile*

C. difficile can cause antibiotic-associated diarrhea that may be complicated to pseudomembranous colitis (a serious inflammation of the colon). Symptoms range from diarrhea to life-threatening inflammation of the colon. Illness from *C. difficile* commonly affects older adults in hospitals and typically occurs after patients taking antibiotic medications.

Prevention and Control

Early and adequate cleansing of contaminated wounds and surgical debridement, together with the administration of antimicrobial drugs directed against clostridia (eg, penicillin), are the best available preventive measures.

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