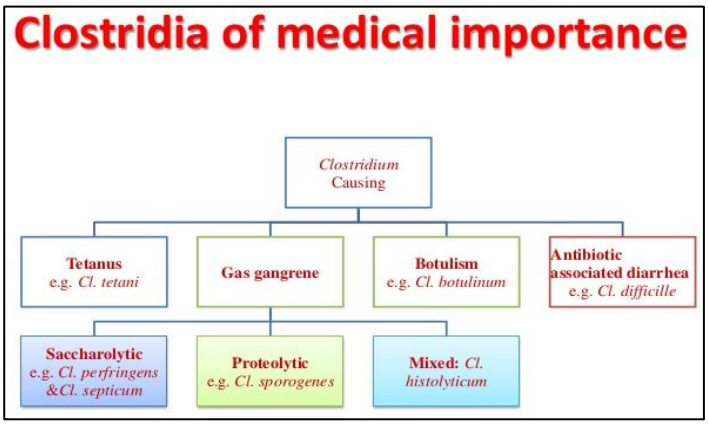
Medical Bacteriology- Lecture 8

Anaerobic Spore- forming Gram Positive Rods

Clostridium



Clostridium

Characteristics

- Large, gram-positive- rod shaped
- All species form **endospores** (spores are located terminally or sub terminally)
- **Anaerobic**
- strictly fermentative type of metabolism (**Most clostridia will not grow under aerobic conditions and vegetative cells are killed by exposure to O2, but their spores are able to survive of exposure to air**)
- live in all of the **anaerobic habitats** of nature, including soils, aquatic sediments and the intestinal tracts of animals.
- Most are motile via peritrichous flagella
- Grow on ordinary medium under anaerobic conditions.
- Clostridia are able to **ferment a wide variety of organic compounds**. They produce end products such as butyric acid, acetic acid, butanol & acetone, and large amounts of gas (CO2 and H2) during fermentation of sugars.
- A variety of **foul smelling compounds are formed during the fermentation of amino acids and fatty acids.**
- The **clostridia produce a wide variety of extracellular enzymes** to degrade large biological molecules (e.g. proteins, lipids, collagen, cellulose, etc.) in the environment. Hence, the clostridia play an important role in nature in biodegradation and carbon cycle. In anaerobic clostridia infections, these enzymes play a role in invasion and pathology.
- Most of the clostridia are saprophytes
- A few are pathogenic for humans;

  • ***C. perfringens***

  • ***C. difficile***

  • ***C. tetani***

  • ***Clostridium botulinum***

Clostridium perfringens

- Capsulated
- Non motile
- causes **wound** and **surgical infections** that lead to **gas gangrene**, in addition to severe **uterine infections**.
- ***C. perfringens*** produces a huge array of **invasins & exotoxins**
- Clostridial **hemolysins** and **extracellular enzymes such as proteases, lipases, collagenase & hyaluronidase**, contribute to the **invasive process**.

•Food poisoning:

- *C. perfringens* produces an **enterotoxin** as an important cause of **food poisoning** (Usually in **improperly sterilized (canned) foods** in which endospores have germinated).
- **Enterotoxin**; heat labile enterotoxin produced by some strains of *C. perfrengens* type A (is the most common food poisoning agents worldwide).
- **Symptoms**; acute abdominal pain, Diarrhea, nausea, usually without vomiting or fever.
- Recovery is rapid and death is rare

•Gas gangrene:

- Attack soft damages tissues and occurs at the site of a recent surgical wound by producing toxins and aggressions.
- Patients who develop this disease often have underlying blood vessel disease, diabetes.
- *C. perfringens* produces **many different toxins**, 4 of which (alpha, beta, epsilon, iota), can cause potentially deadly syndromes, damage tissues, blood cells and vessels.
    - Alpha toxin (lecithinase) causes RBC rupture, edema , and tissue destruction
    - Gas formed in the tissues can destroy muscle tissue

Symptoms: Gas gangrene is marked by a high fever, brownish pus, gas bubbles under the skin, skin discoloration, and a foul odor.

Virulence Factors:

1- Toxins; **Alpha toxin** (Phospholipases C, Lecithinase), is the most important toxin

Beta toxin (responsible for necrotic lesions)

Enterotoxin (heat labile toxin produced in colon, food poising)

2- Collagenase

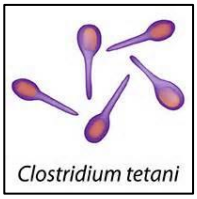
3- Hyaluronidase

4- DNase

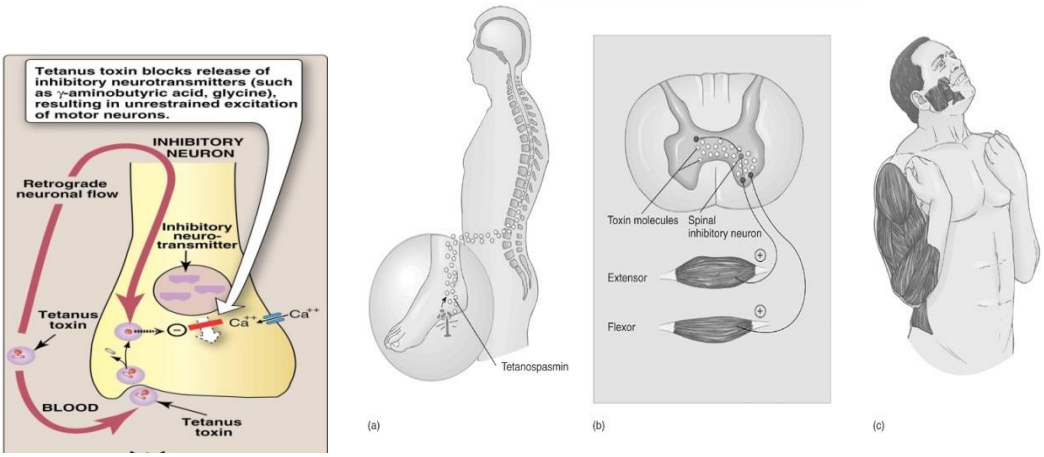
Treatment and prevention: **Myositis;** wound debridement
Antibiotics (penicillin, cephalosporin)
Hyperbaric oxygen therapy may detoxify patient rapidly
Food poising, require only symptomatic care

No vaccine available.

Clostridium tetani



- *C. tetani* is the causative agent of **tetanus** (a highly fatal disease of humans).
- The organism is found in soil, the intestinal tracts & feces of animals.
- The organism produces **terminal spores (distinctive drumstick).**
- Non motile
- Most cases of tetanus result from small puncture wounds, burns, which become contaminated with *C. tetani* spores that germinate and produce toxin.
- The organism multiplies locally (non-invasive), the infection remains locally and symptoms appear remote from the infection site.
- a potent **neurotoxin** (**tetanus exotoxin toxin** or **tetanospasmin**) produced when spores germinate and during vegetative cells grow.
- **Toxin Mode of action: It migrates along neural paths from a local wound to the central nervous system. Inhibit release neurotransmitters from neve ending**
- The clinical pattern of tetanus consists of **severe painful spasms and rigidity of the voluntary muscles**. The characteristic symptom of **"lockjaw"** involves **spasms of the masseter muscle**. Spasms of the pharyngeal muscles cause difficulty in swallowing. Death usually results from interference with the mechanics of respiration.
- Most cases occur over age 60 (waning immunity is a significant risk factor).
- The widespread use of the **tetanus toxoid (inactive toxin)** to make anti-tetanus antibody for prophylactic immunization.



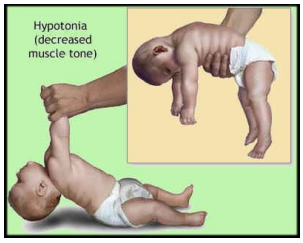
Clostridium botulinum

- **Subterminal endospores (**Spores more resistant than any other anaerobe, 6 hrs boiling)
- It is widely distributed in soil, sediments of lakes. The intestinal tracts of birds, mammals and fish may occasionally contain the organism.
- Found in honey, carried by bees.
- Causes **Botulism (neurotoxin)** - food poising
- **Produce most potent biological known** toxin to affect humans.
- **Botulinum toxin** (7 types). **Type A** is the most significant cause of botulism.
- Not all strains of *C. botulinum* produce the botulinum toxin.
- It resembles **Staphylococcal or *B. cereus* food poisoning.**

Food-borne Botulism:

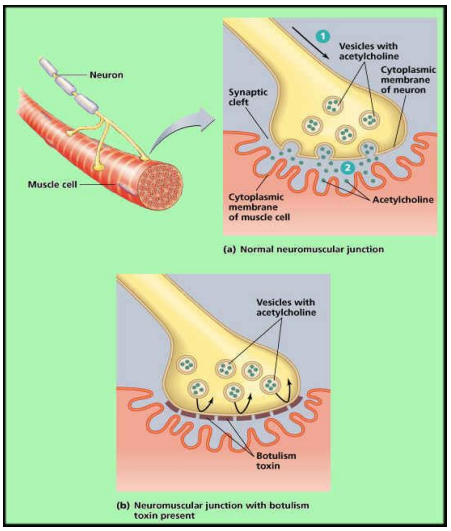
- **Intoxication infection (results from the ingestion of improperly canned foods that contain botulinum neurotoxin).**
- **Botulinum toxin is ingested with food in which spores have germinated and the organism has grown.**
- The toxin is absorbed by the upper part of the gastrointestinal tract (GI) tract and passes into blood stream by which it reaches the neuromuscular synapses.
- **Botulism toxin mode of action;** it binds to the presynaptic stimulatory terminals and **blocks the release of the neurotransmitter acetylcholine which is required for a nerve to simulate the muscle.**
- Clinical symptoms of botulism muscular **paralysis** begin 18-36h after toxin ingestion with **weakness, dizziness & dryness of the mouth. Nausea & vomiting may occur. Neurologic features including blurred vision, inability to swallow, difficulty in speech, weakness of skeletal muscles and respiratory paralysis.**

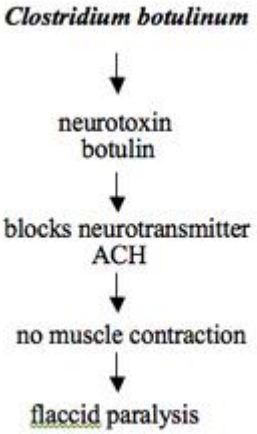
Infant Botulism



- occurs in infants 5 - 20 weeks of age.
- **It is characterized by paralysis,** constipation and weak sucking ability and generalized weakness. Flat facial expression, A weak, feeble cry, Muscle weakness and decreased movement. Poor head control, Breathing problems and respiratory failure.
- **Infant botulism is caused by consuming the spores of the botulinum bacteria, which germinate and then grow in the intestines and release botulinum toxin within the infant's large intestine.**
- *C. botulinum* can apparently establish itself in the bowel of infants at a critical age before the establishment of competing intestinal flora. Production of toxin by bacteria in the GI tract induces symptoms. This "infection-intoxication" is restricted to infants.

- *C. botulinum* organisms, as well as toxin, can be found in the feces of infected infants.
- Almost all known cases of the disease have recovered. The possible role of infant botulism in "sudden infant death syndrome-SIDS" has been suggested but remains unproven.





Clostridium difficile

- *C. difficile* causes **antibiotic-associated diarrhea (AAD)** and more serious intestinal conditions such as **pseudomembranous colitis** in humans.

- These conditions generally result from overgrowth of *C. difficile* in the colon, usually after the normal **intestinal microbiota flora has been removed by antimicrobial chemotherapy.**

- Healthy persons usually do not get *C. difficile* disease. Individuals who have other conditions that require prolonged use of antibiotics, immunocompromised. gastrointestinal surgery.

- ***C. difficile* produces two toxins:**
- **Toxin A** is referred to as an enterotoxin; causes fluid accumulation in the bowel; causes diarrhea
- **Toxin B** is an extremely lethal (cytopathic) toxin; causes necrosis in intestinal wall.

- Severe cases exhibit cramping, fever, and leukocytosis

- *C. difficile* infections can usually be treated successfully with a 10-day course of antibiotics including vancomycin (administered orally).

Review Questions

- What is the major characteristics of Clostridia?
- Write the Latin name of the bacteria that causes:

  A. Botulism B. Tetanus C. Gas gangrene D. Antibiotic associated diarrhea (pseudomembranous colitis)

- Compare between adult botulism and infant botulism?

- Some *Clostridium* species can cause food poisoning. Give two examples?

- What is the mode of action of botulism toxins and tetanus toxins, types of toxins, major symptom?

- What is the symptoms of gas gangrene, tetanus?

- What is the most potent known toxin?