Bacillus and Corynebacterium

Objectives:

Gram-Positive Rods:
1-Bacillus.
2-Corynebacterium.

Aerobic Gram-Positive Bacilli:

***Bacillus* Species:**

- Most of it found in soil and water.
- Most are saprophytic and are isolated as contaminants.
- Gram-positive large rods with “empty” spaces.
- Form endospores (Highly resistant to heat, drying, and chemicals) .
- Catalase positive.

Bacillus anthracis:

- Anthrax affect principally domestic **herbivores (sheep, goats and horses).**
- **Humans acquire infection by contamination of wound or ingestion or inhalation of spores.**

- ## Morphology:
  - Large, spore-forming gram-positive bacilli.
  - **Spores viable for >50 years.**
  - **Non-hemolytic on sheep blood agar.**

Pathogenesis of *Bacillus anthracis:*

Virulence factors of *Bacillus anthracis:*

***Bacillus anthracis* possess:**

1. **Capsule: that is antiphagocytic.**
2. **Exotoxins:**

- **Edema factor: is responsible for the severe edema usually seen.**
- **Lethal toxin: is responsible for additional adverse effects.**

Clinical significance of *Bacillus anthracis:*

- **Incidence of infection is very low.**
  - **Fewer than five cases per year.**
  - Woolsorter's disease; Ragpicker's disease.
  - Handling fibers, hides, or other animal products.
- **Most infections are cutaneous anthrax**
  - **Enter through cuts causing a localized infection.**
  - **Malignant pustule or black eschar.**
    - **Painless and nonpus producing.**
    - **Produces a permanent scar.**

Cutaneous anthrax:

- **About 95% of human cases of the cutaneous form.**
- **A papule develops upon introduction of organisms or spores.**
- **It rapidly evolves into painless , black , severely swollen (malignant pustule) which eventually crust over.**
- **septicemia.**

Pulmonary anthrax or "woolsorter's disease":

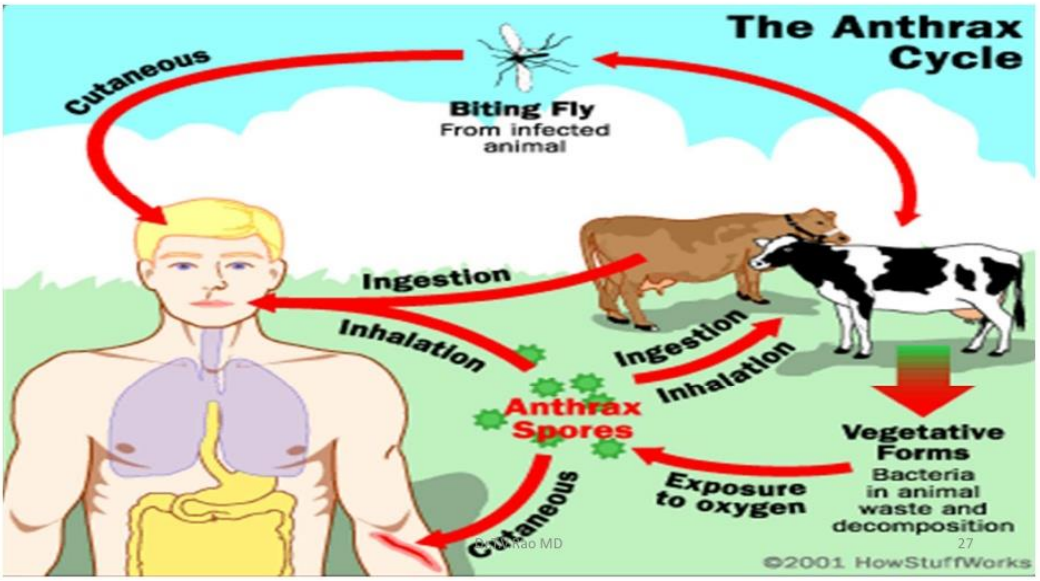
- **Acquired through inhalation of spores.**
- It is characterized by progressive hemorrhagic lymphadenitis (inflammation of the lymph nodes).

Gastrointestinal anthrax:

- **Acquired by ingestion of contaminated raw meat.**
- Inoculates into a lesion on the intestinal mucosa.
- Abdominal pain, nausea, anorexia, vomiting, and sometimes bloody diarrhea.

-More likely to be fatal but less likely to occur than cutaneous form.

Anthrax Cycle



Identification of *Bacillus anthracis:*

- **Microscopic morphology:**
  - Large, square-ended gram-positive rods.
  - Bamboo appearance.
- **Colonial morphology**

  Nonhemolytic on 5% blood agar; raised, large, grayish white, irregular, fingerlike edges.

  “Medusa head” or “beaten egg whites”

B.anthracis colonies:

Suspecting Anthrax:

- Work in biologic safety cabinet.
- Non-hemolytic on BAP.
- non-motile.
- **Produces lecithinase.**
- String of pearls morphology.

Characteristics to Differentiate *B. anthracis* from *B. cereus.*

TABLE 16-6 Differentiation of *Bacillus anthracis* and *Bacillus cereus*

Characteristic	*B. anthracis**	*B. cereus**
Hemolysis on sheep blood agar	–	+
Motility	–	+
Penicillin susceptibility	S	R
Lecithinase production	+	+
Fermentation of salicin	–	+/–
Growth in penicillin (10 U/mL) agar	–	+
"String of pearls" reaction	+	–
Gelatin hydrolysis	–	+
Growth on phenylethyl alcohol agar	–	+

Modified from Braude AI et al, editors: *Infectious diseases and medical microbiology*, Philadelphia, 1986, Saunders.
S, Sensitive; *R,* resistant.
*All cultures were incubated at 36° to 37° C.

Table 16-6. Differentiation of *Bacillus anthracis* and *Bacillus cereus*

Treatment of Anthrax:

- **Most isolates are susceptible to penicillin.**
  - **Resistance can occur due to beta-lactamase production.**
- **Ciprofloxacin was approved by FDA for treatment.**
  - **Until susceptibility results are known.**

Prevention:

- **Autoclaving is the most reliable means of decontamination , because of the resistance of endospores to chemical disinfectants.**
- **Vaccine is available for workers in high-risk occupations.**

Bacillus cereus:

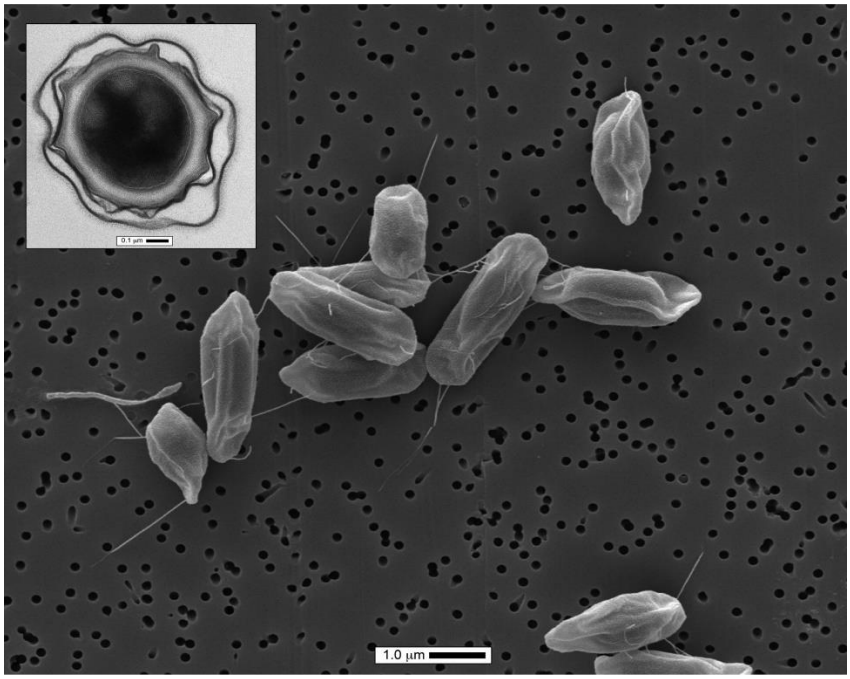
- **Food poisoning.**
  - **Caused by distinct enterotoxins**
  - **Diarrheal syndrome:**
    - **Associated with meat, poultry, and soups.**
    - Incubation period of 8 to 16 hours.
    - Fever uncommon.
    - Resolves within 24 hours.
  - **Emetic form:**
    - **Associated with fried rice.**
    - Abdominal cramps and vomiting.
    - Incubation period of 1 to 5 hours
    - Resolves in 9 hours.

Other *Bacillus* Species:

- *B. subtilis*
- *B. licheniformis*
- *B. circulans*
- *B. pumilus*
- *B. sphaeric*

Key Characteristics of Bacillus Species

Characteristic	B.Anthracis	B. Cereus	Other Bacillus
Beta-hemolysis	Negative	Positive, Large zones	variable
Motility	Negative	Positive	Positive
Pencillin	Sensitive	Resistant	Variable



Corynebacterium Species: General Characteristics:

- **Found as free-living saprophytes.**
  - **Water, soil, air.**
  - **Resistant to drying.**
  - **Small , slender , polymorphic , gram positive rod.**
  - Do not form spores.
  - Non-motile .
  - Tend to stain unevenly.
  - **Occur in characteristic clumps that look like chinese character.**
  - Most species are facultative anaerobes.

C. diphtheria:

- **Toxigenic *Corynebacterium diphtheria:***
  - **Worldwide distribution.**
    - Rare in places where vaccination programs exist.
- **Exotoxin is a major virulence factor.**

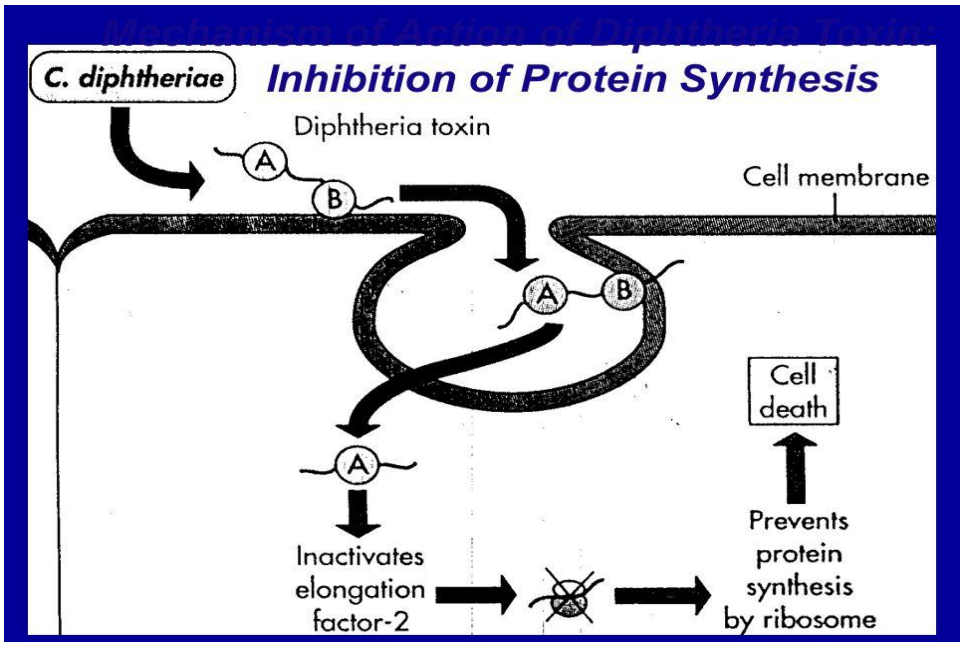
Diphtheria toxin:

-Toxin is produced by certain strains.

- **Toxin is antigenic…**
  - **Thus can stimulates productions of antibodies that neutralize toxin's activity.**

Pathogenesis:

- Diphtheria is caused by local and systemic effect of single exotoxin that **inhibit protein synthesis.**
- The toxin molecules composed of two fragments **A** and **B.**
  - **A: Active fragment.**
    - Inhibits protein synthesis.
    - Leads to cell/tissue death.
  - **B: Binds to specific cell membrane receptors**
    - Mediates entry of fragment A.
    - A single molecule of Diphtheria toxin can inhibit all protein synthesis in eukaryotic cells within hours of its introduction.



Clinical Infections of Diphtheria:

- **Local infection**:

- usually of the throat , produces distinctive thick , grayish , adherent exudates called **pseudomembrane.**

- **Upper respiratory tract infection:**
  - **Acquired by droplet spray.**
  - Aerosol or hand to mouth contact.
  - Unimmunized individuals are susceptible.

- **Cutaneous Diphtheria:**
  - **Puncture wound or cut in the skin can result in the introduction** of *C.diphteria* into subcutaneous tissue.

- **Other Systemic effects:**
  - Toxin is absorbed in the bloodstream and carried systemically
  - All human cells sensitive to diphtheria toxin ,the major clinical effects ,involve the heart, and peripheral nerves system.
  - Death occurs due to cardiac failure.

Laboratory identification:

- Clinical observation.
- **Isolation of the organism , which must be tested for virulence using:**
  - **Animal inoculation.**
  - **Immunologic precipitin reaction.**
- **Isolation in selective medium (Tinsdale's agar).**

Treatment of Diphtheria:

- **Treatment of diphtheria requires prompt neutraization of toxin ,followed by eradication of the organism.**
- **A single dose of horse serum antitoxin inactivates any circulating toxin.**
- ***C.diphtheriae* sensitive to several antibiotics ,such as erythromycin or penicillin.**

Diphtheroid:

- A number of other corynebacterium species that morphologically resemble the type species *C.diphtheriae*
- Common commensals of the nose , throat , nasopharynx , skin ,urinary tract , and conjunctiva
- e. g. ***C.ulcerans*** causes a mild diphtheria-like illness

Several species of corynebacteria have been recovered in infections such as endocarditis of prosthetic valves ,lung abscess and UTI.

Other species of Corynebacteria:

- *C. jeikeium*
- *C. pseudodiphtheriticum*
- ***C. pseudotuberculosis***
- *C. striatum*
- *C. ulcerans*
- *C. urealyticum*
- *C. xerosis*