

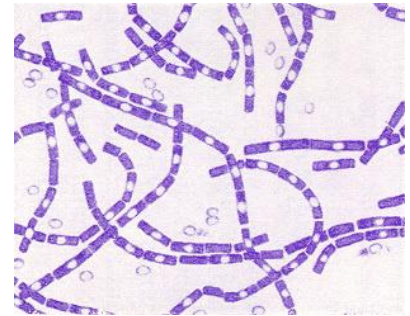


## Multi-Organ Diseases Due to Bacterial Infection

### Anthrax

#### Etiology

- *Bacillus anthracis*.
  - Gram-positive, rod-shaped, square-ended, aerobic, immobile, capsulated, spore-forming.
  - Easily withstand cold temperatures.
  - Survives in dried and salted hides.
  - Spores survive in soil for many years (sporulation occur with exposure to free oxygen).



Todar's Online Textbook of Bacteriology :  
<http://textbookofbacteriology.net/Anthrax.html>

#### Epidemiology

- **Occurrence**
  - Most common in cattle and sheep, and less frequent in goats and horses.
  - Global occurrence - occurs as outbreaks.
  - Sporadic disease in western Europe, North America, and Australia.
  - In tropical and subtropical climates with high annual rainfalls, the infection persists in the soil – thus, the disease occurs as a frequent serious outbreak.
- **Source of the Infection**

Direct: from soil, fodder grown on infected soil, contaminated bone meal or protein concentrates, infected excreta, blood, or other discharges from infected animals.
- **Transmission of the Infection**
  - Ingestion – contaminated food and water.
  - Inhalation - contaminated dust (minor importance in animals).
  - Skin – abrasions or lesions.
- **Risk Factors**
  - soil-borne infection occur after a major climate change – e.g., heavy rain after a prolonged drought, or dry summer months after prolonged rain
  - grazing of tough scratchy feed in dry times – results in abrasions of the oral mucosa.
- **Zoonotic Potential**

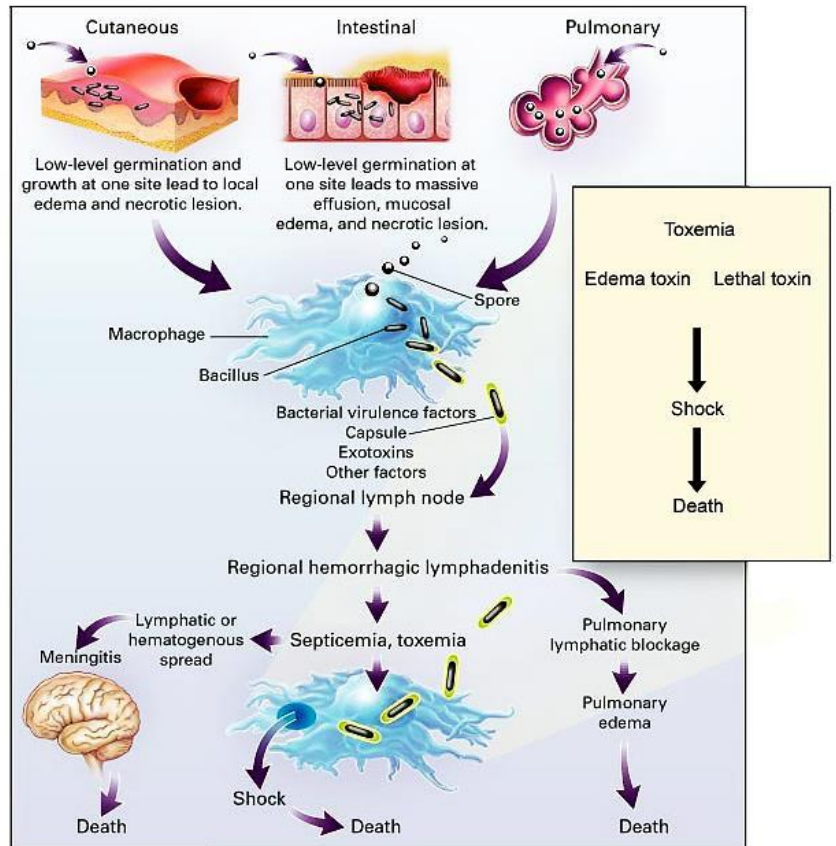
Anthrax is an important cause of fatal human illness. Human infection comes from:

  - handling infected carcasses
  - eating meat from infected animals – develop alimentary form.
  - postmortem examination of carcasses (in veterinarians) – develop Cutaneous form.



## Pathogenesis

- Site of entry spores ← macrophages → regional lymph nodes → bloodstream → septicemia with massive invasion of all body tissues.
  - Toxin causes edema and tissue damage, acute renal failure, terminal anoxia, and death due to shock.
  - Hemorrhage to the exterior from orifices of the animal at death is caused by the action of the toxin on the endothelial cell lining of blood vessels, resulting in breakdown and bleeding.



The diagram adopted from:

Dixon TC et al. N Engl J Med 1999;341:815-826

<https://www.nejm.org/doi/full/10.1056/NEJM199909093411107>

## Clinical findings

- The incubation period after field infection is probably 1 to 2 weeks.
- The severity of the clinical signs depends on the infectious dose, the quality of the bacillary capsule, the amount of toxin produced, and the susceptibility of the host species.
- The peracute form:
  - Most common at the beginning of an outbreak.
  - The animals are usually found dead without premonitory signs.
    - fever, muscle tremor, dyspnea, and congestion of the mucosae may be observed.
  - After death, discharges of blood from all body orifices, including the nostrils, mouth, anus, and vulva can occur.
- The acute form:
  - Severe depression and listlessness are usually observed first
  - The body temperature is high, up to 42° C (107° F).
  - The mucosae congested and hemorrhagic.
  - The respiration rapid and deep, the heart rate much increased.
  - No food is taken, and ruminal stasis is evident.
  - Pregnant cows may abort.



- In milking cows, the yield is very much reduced, and the milk may be bloodstained or deep yellow in color.
- Alimentary tract involvement - diarrhea and dysentery.
- Local edema of the tongue and edematous lesions in the region of the throat, sternum, perineum, and flanks may occur.
- In horses:
  - When infection is by ingestion – septicemia with enteritis and colic as a result of intestinal irritation.
  - When infection is by insect transmission – hot, painful, edematous, subcutaneous swellings appear about the throat, lower neck, floor of the thorax and abdomen, prepuce, and mammary gland.
  - High fever, severe depression, and dyspnea as a result of swelling of the throat

### **Clinical pathology**

- Hematology and blood chemistry are not performed because of risk for human exposure.
- Demonstration of the organism in blood or subcutaneous edema fluid or lymph nodes “square-ended bacilli (often in chains)”.
  - Blood should be carefully collected in a syringe to avoid contamination of the environment.
- Other diagnostic confirmation included: monoclonal antibody-fluorescent conjugates, culture, Ascoli test, and PCR.
- Shipping infectious material presents risk for spread of the pathogen and human exposure. Before planning to ship infectious material to a diagnostic laboratory, local authorities and the diagnostic laboratory should be consulted.

### **Necropsy findings**

- Carcass should not be opened if anthrax suspected, when there is:
  - Exudation of tarry blood from the body orifices of the cadaver,
  - Failure of the blood to clot,
  - Absence of rigor mortis,
  - Splenomegaly.
- The diagnosis is made from the examination of aspirated carcass blood.

### **Treatment**

- Severely ill animals are unlikely to recover.
- In early stages, when fever is detected before other signs are evident:
  - Penicillin G sodium/potassium (20,000 IU/kg IV every 12h at least as loading dose IV).
  - Procaine penicillin (22,000 IU/kg IM every 12h or 44,000 IU kg IM q24h).
  - Oxytetracycline (10 mg/kg IV or IM every 24h).
  - Anthrax hyperimmune serum.
- The treatment of anthrax in livestock is legally prohibited in certain countries.
  - Destruction of animals with clinical signs of anthrax without spilling of blood is required.
  - Some countries even require the slaughter of the entire herd following a case of anthrax.



## Control

- In an outbreak situation:
  - Place the farm in quarantine.
    - Movement of milk and meat from the farm during the quarantine period is prohibited.
  - Destruct discharges and cadavers,
    - Infected carcasses should not be opened but immediately burned together with manure, bedding, and soil contaminated by discharges.
      - Deep burial may be used but increases risk of groundwater contamination.
      - If the carcass and infectious material cannot be disposed of immediately, apply 5% formaldehyde on the carcass
    - Administration of hyperimmune serum to in-contact animals may prevent further losses during the quarantine period.
      - Prophylactic single dose of long acting tetracycline or penicillin is common.
  - Disinfection of premises:
    - Before spore formation - disinfectants or heat (60 C [140° F]) for a few minutes.
    - When spore formation expected to have begun (within few hours of exposure to the air):
      - Strong disinfectants such as 5% Lysol for at least 2 days.
      - Strong solutions of formalin or sodium hydroxide (5% to 10%).
    - Infected clothing - soaking in 10% formaldehyde.
    - Shoes - placing them in a plastic bag and introducing ethylene oxide.
    - Special care must be taken to avoid human contact with infected material; if such contact does occur, the contaminated skin must be thoroughly disinfected.
  - Vaccinate survivors
    - Live attenuated vaccines, capsulated and nontoxigenic (cap +/tox-).
    - Live attenuated vaccines, noncapsulated and toxigenic (cap-/tox +).
      - Because currently used anthrax vaccines contain live attenuated bacteria, they should not be used in combination with antimicrobial therapy.
- When the disease occurs for the first time in a previously clean area,
  - All in-contact animals should either be treated with hyperimmune serum or be vaccinated.
    - The measures used to control outbreaks, and the choice of a vaccine depend largely on local legislation and experience.
  - Surface contamination of a pasture can persist for 3 years, and cattle grazing these pastures should be revaccinated annually for this period.
  - In endemic areas cattle are routinely vaccinated yearly.
  - Milk from vaccinated cows is usually discarded for 72 hours after the injection.

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### References:

- Constable PD, Hinchcliff KW, Done SH, et al. (2017). *Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats*. 11<sup>th</sup> ed. Elsevier, St. Louis, Missouri, USA.

