

## **Spore-Forming Gram-Positive Bacilli**

### **Genera: *Bacillus* and *Clostridium***

The Gram-positive spore-forming bacilli are the *Bacillus* and *Clostridium* species. These bacilli are **form spores**, they can survive in the environment for many years. *Bacillus* species are **aerobes**, and the *Clostridium* species are **anaerobes**.

### **Genus: *Bacillus***

The members of this genus are closely related but differ both phenotypically and in pathogenesis. Most members of this genus are saprophytic organisms prevalent in soil, water, air, and on vegetation.

*Bacillus* and related genera, do not cause disease and are not well characterized in medical microbiology. There are a few species, that cause important diseases in humans.

### **Morphology and Identification**

The genus *Bacillus* includes large aerobic, Gram-positive rods occurring in chains, have square ends and are arranged in long chains; **spores are located in the center of the bacilli**. The spores are resistant to environmental changes, withstand dry heat and chemical disinfectants for moderate periods, and persist for years in dry earth. Items contaminated with anthrax spores can be sterilized by autoclaving or irradiation.

### ***Bacillus anthracis***

#### **Pathogenesis**

**Anthrax**, a classical disease in the history of microbiology, is caused by *Bacillus anthracis*. Anthrax remains an important disease of animals and humans. Because of its potent toxins, *B. anthracis* is a major

agent of bioterrorism and biologic warfare. Anthrax toxins are made up of **three proteins: protective antigen (PA), edema factor (EF), and lethal factor (LF).**

Anthrax is primarily a disease of herbivores—goats, sheep, cattle, horses. In animals, the portal of entry is the mouth and the gastrointestinal tract. Spores from contaminated soil find easy access when ingested with vegetation.

Humans become infected by contact with infected animals or their products, the infection is usually acquired by the entry of spores through injured skin (**cutaneous anthrax**) or by inhalation of spores into the lung (**inhalation anthrax**) or rarely entry to the mucous membranes (**gastrointestinal anthrax**).

**Cutaneous anthrax** occurs on exposed surfaces of the arms or hands followed by the face and neck. A pruritic papule develops 1–7 days after entry of the organisms or spores through a scratch. Initially, it resembles an insect bite. The papule rapidly changes into a vesicle and a necrotic ulcer have a characteristic central black eschar.

**Inhalation anthrax** (wool sorters' disease), the spores from the dust of wool, hair, or hides are inhaled; phagocytosed in the lungs; and transported by the lymphatic drainage to the lymph nodes, where germination occurs. This is followed by toxin production and the development of hemorrhagic and sepsis, which are usually rapidly fatal.

**Gastrointestinal anthrax** is very rare; it has been reported from Africa, Asia, and the United States when people have eaten raw or undercooked meat from infected animals with *Bacillus*.

The spores germinate in the tissue at the site of entry, and growth of the vegetative organisms results in formation of a gelatinous edema and congestion. Bacilli spread via lymphatics to the bloodstream, and they multiply freely in the blood and tissues shortly before and after the animal's death.

### **Diagnostic Laboratory Tests**

Specimens to be examined are fluid or pus from a local lesion. Pleural fluid, blood and cerebrospinal fluid in inhalational anthrax associated with sepsis and stool or other intestinal contents in the case of gastrointestinal anthrax. Stained smears from the local lesion or blood show chains of large Gram-positive rods of *Bacillus* species.

Culture can be done on blood agar plates, the organisms produce non-hemolytic gray to white colonies with a rough texture and a ground-glass appearance. Comma shaped outgrowths (Medusa head, “curled hair”) may project from the colony.

### **Treatment**

Many antibiotics are effective against anthrax in humans, but treatment must be started early. Ciprofloxacin is recommended for treatment; other agents with activity include penicillin G, doxycycline, erythromycin, and vancomycin.

Antibiotic therapy in last stages of disease does not appear to change the natural progression of the disease but prevents dissemination. In as many as 20% of patients, cutaneous anthrax can lead to sepsis of systemic infection—including meningitis—and death.

## ***Bacillus cereus***

*Bacillus cereus* is commonly found in soil and food. The specific name, cereus, meaning "waxy" in Latin, refers to the appearance of colonies grown on blood agar. Some strains are harmful to humans and cause **foodborne illness or food poisoning**. The bacteria is contracted from fried rice dishes that have been sitting at room temperature for hours.

### **Pathogenesis**

*Bacillus cereus* can grow in foods and cause food poisoning by producing either:

**a. an enterotoxin (diarrheal)**

**b. an emetic toxin (vomiting)**

*Bacillus* foodborne illnesses occur due to survival of the bacterial endospores when infected food is not, or inadequately, cooked. Cooking temperatures less than or equal to 100 °C allow some *B. cereus* spores to survive. This problem is compounded when food is then improperly refrigerated, allowing the endospores to germinate.

## ***Bacillus subtilis***

*Bacillus subtilis* known also as the hay bacillus or grass bacillus, contributed in laboratory contamination.

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