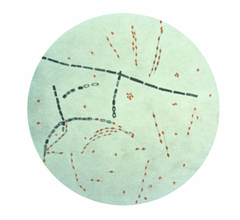
**Microbiology Dr.Sukayna Jabbar**

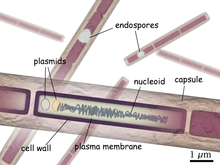
The symptoms of anthrax depend on the type of infection and can take anywhere from 1 day to more than 2 months to appear.  All types of anthrax have the potential, if untreated, to spread throughout the body and cause severe illness and even death.

* Cutaneous, the most common form (95%), causes a localized, inflammatory, black, necrotic lesion eschar.
* Inhalation, a rare but highly fatal form, is characterized by flu like symptoms, chest discomfort, diaphoresis, and body aches.
* Gastrointestinal, a rare but also fatal (causes death to 25%) type, results from ingestion of spores. Symptoms include: fever and chills, swelling of neck, painful swallowing, hoarseness, nausea and vomiting (especially bloody vomiting), diarrhea, flushing and red eyes, and swelling of abdomen.
* Injection, symptoms are similar to those of cutaneous anthrax, but injection anthrax can spread throughout the body faster and can be harder to recognize and treat compared to cutaneous anthrax.
* Meningeal : Meningitis and meningo-encephalitis may occur secondary to septicaemia or primary anthrax meningitis may occur due to inhalation of spores reaching the central nervous system directly.

*Bacillus anthracis*

[](https://en.wikipedia.org/wiki/File:Bacillus_anthracis.png)

*Bacillus anthracis* is the [etiologic](https://en.wikipedia.org/wiki/Etiology) agent of [anthrax](https://en.wikipedia.org/wiki/Anthrax)—a common disease of livestock and, occasionally, of humans—and the only obligate [pathogen](https://en.wikipedia.org/wiki/Pathogen) within the genus [*Bacillus*](https://en.wikipedia.org/wiki/Bacillus).[[1]](https://en.wikipedia.org/wiki/Bacillus_anthracis#cite_note-Spencer-1) *B. anthracis* is a [Gram-positive](https://en.wikipedia.org/wiki/Gram-positive), [endospore](https://en.wikipedia.org/wiki/Endospore)-forming, rod-shaped [bacterium](https://en.wikipedia.org/wiki/Bacterium), with a width of 1.0–1.2 [µm](https://en.wikipedia.org/wiki/%CE%9Cm) and a length of 3–5 [µm](https://en.wikipedia.org/wiki/%CE%9Cm). It can be grown in an ordinary nutrient medium under aerobic or anaerobic conditions.*B. anthracis* belongs to the *B. cereus* group of strains.

[](https://en.wikipedia.org/wiki/File:B_anthracis_diagram_en.png)

Structure of *B. anthracis*

It is one of few bacteria known to synthesize a protein capsule (poly-D-gamma-glutamic acid). Like [*Bordetella pertussis*](https://en.wikipedia.org/wiki/Bordetella_pertussis), it forms a [calmodulin](https://en.wikipedia.org/wiki/Calmodulin)-dependent [adenylate cyclase](https://en.wikipedia.org/wiki/Adenylate_cyclase) exotoxin known as ([edema factor](https://en.wikipedia.org/wiki/Anthrax_toxin)), along with [lethal factor](https://en.wikipedia.org/wiki/Anthrax_lethal_factor_endopeptidase). It bears close [genotypical](https://en.wikipedia.org/wiki/Genotypical) and [phenotypical](https://en.wikipedia.org/wiki/Phenotypical) resemblance to [*Bacillus cereus*](https://en.wikipedia.org/wiki/Bacillus_cereus) and [*Bacillus thuringiensis*](https://en.wikipedia.org/wiki/Bacillus_thuringiensis). All three species share cellular dimensions and morphology. All form oval spores located centrally in an unswollen sporangium. *B. anthracis* spores, in particular, are highly resilient, surviving extremes of temperature, low-nutrient environments, and harsh chemical treatment over decades or centuries.

Historical background

[](https://en.wikipedia.org/wiki/File:Bacillus_anthracis_-_CapD_protein_crystal_structure.jpg)

CapD protein crystal structure of *B. anthracis*

Genome structure

*B. anthracis* has a single chromosome which is a circular, molecule.It also has two circular, extrachromosomal, double-stranded DNA plasmids, pXO1 and pXO2. Both the pXO1 and pXO2 plasmids are required for full virulence and represent two distinct plasmid families.

Diagnosis

Bacteriologic Tests

*Bacillus anthracis* is a large, gram-positive, aerobic, sporeforming bacillus that measures 1.0 to 1.5 μm by 3.0 to 10.0 μm . Methylene blue stained smear of CSF, blood, pleural fluid shows long and thick bacilli, surrounded

by amorphous purplish area representing the capsular material (the McFadyean reaction).3 A part of the *B. cereus* group of bacilli, *B. anthracis* is easy to differentiate from other members of the *B. cereus* group by observing the morphologic features of the colony on a blood-agar plate. Colonies of most *B. anthracis*

isolates are non-hemolytic and are white to gray, often looking

like ground glass. It is nonmotile, is nonhemolytic on sheep’sblood

agar, grows readily at a temperature of 37°C, and forms

large colonies with irregularly tapered outgrowths (a “Medusa

head” appearance generally seen with the low power objective

of the microscope where the tangled bacilli appear like the

serpents on the mythological Medusa head).5 In vitro it grows

as long chains, but in the host it appears as single organisms

or chains of two or three bacilli. It forms mucoid colonies and

exhibits a prominent capsule when grown on nutrient agar

(containing 0.7 percent sodium bicarbonate in the presence of 5

to 20 percent carbon dioxide). It is identified as *B. anthracis* by

standard biochemical reactions.

The culture of tissue grows *B. anthracis*; however, all

cutaneous samples may not be positive for the bacteria.

Nevertheless, other samples like blood, pleural fluid, CSF

grow large number of encapsulated bacilli. The bacteria may be

dismissed as contaminant by laboratory staff unless physician

specifically requests testing.3 Blood cultures in cases of systemic

anthrax infection are almost always positive, because of the large

numbers of bacterial cells in the circulation. Cultures of tissue

from skin lesions, however, are not useful diagnostically, because

the rate of positive cultures does not exceed 60 to 65 percent,

probably owing to the microbicidal activity of local antagonistic

skin flora. However, in a study in our hospital, in all the 23 cases

of cutaneous anthrax, aspirated material showed the specific

bacilli,9 though the organisms were fewer in number. There

are reports of clinical isolates of *B. anthracis* that are resistant to

penicillin.3 Because of the potential for drug-resistant strains,

including deliberately modified strains, antibiotic-susceptibility

testing should be performed on all isolates.

Serologic and Immunologic Tests

The major immunogenic proteins of *B. anthracis* appear to

be capsular antigens and the exotoxin components. Specific

enzyme-linked immunosorbent assays (ELISAs) that show a

quadrupling of the titer of antibodies against these components

are diagnostic of past infection or vaccination. The most reliable

indicators are the titers of antibody to protective antigen and to

capsular components. In studies of the measurement of antibody

titers by ELISA, the sensitivity of possible indicators was as

follows: 72 percent for protective antigen, 95 to 100 percent for

capsule antigens, 42 percent for lethal factor, and 26 percent

for edema factor. Indirect microhemagglutination gives results

similar to those obtained with ELISA but has certain drawbacks,

including the short shelf life of antigen-sensitized red-cell

preparations, the limited reproducibility of the test, and longer

preparation times.3

Cultural Characteristics

*B. anthracis* is a non-fastidious organism and can grow on simple

laboratory media. They are facultative anaerobes. The optimum

temperature for growth is 37°C and the pH, 7.0–7.4.

Nutrient agar (NA)

After overnight incubation at 37oC colonies are large 2–3 mm in

diameter, irregular, raised, dull, opaque and grayish white with ‘frosted

glass’ (ground glass) appearance. The edge of colonies may be curled or

fringed edges with long interlacing chains of bacilli resembling curly

locks. This is referred to as “medusa

head appearance” but is not

encountered as frequently as

textbooks often suggest. The

colony is membranous in

consistency and hence not easily

emulsifiable.

Sheep blood agar (SBA)

Lack of haemolysis is the norm.

Weak haemolysis may be observed

very rarely under areas of confluent

growth, which should not be

confused with beta haemolysis.

On sheep blood agar the colonies are nonhaemolytic

2-3mm in diameter, irregular,

raised, opaque and grayish white with a

'frosted glass' appearance. The edge of

the colonies are curled or fringed having

a 'medusa head' appearance

Culture smear of *B. anthracis* stained with

malachite green. The spores which are

oval and non bulging are stained green

and the bacilli, red.

Manual for Laboratory

Diagnosis of Anthrax 3

Nutrient broth (NB)

No turbidity or very fine floccular turbidity is seen with floccular deposit.

The deposit comes up as silky strands on shaking the broth gently, because

of the tendency to form long chains in vitro and tenacious growth

character of the organism.

PLET medium 2

This medium is used for the isolation of *B. anthracis* from contaminated

clinical materials or environmental samples. It consists of heart infusion

agar with polymyxin, lysozyme, ethylene diamine tetra acetic acid

(EDTA) and thallous acetate. After incubation at 37°C for 36–48 hours,

the colonies of *B. anthracis* are 1–3 mm, roughly circular, creamy white

with ground-glass texture. Colonies are usually smaller in size on this

medium compared to NA or SBA.

Polymyxin blood agar 3

This medium is useful for testing unheated suspensions of old decomposed

or processed animal specimens or environmental specimens and reduces

or prevents growth of many Gram-negative bacteria.

Bicarbonate agar 4

Colonies are mucoid in nature on this medium due to capsule formation.

3.2 Special Features

Susceptibility to penicillin G 5

*B. anthracis* is almost always susceptible to penicillin, as shown by

susceptibility to penicillin G 10 units discs on Mueller-Hinton agar. In

contrast the non-pathogenic *Bacillus* species are more generally resistant

to penicillin.

Susceptibility to gamma bacteriophage 6

Gamma Phage has the ability to lyse *B. anthracis* grown aerobically on

blood or other nutrient agar and rarely lyses any other *Bacillus* species.

Animal pathogenicity test

A definitive identity of a suspect *B. anthracis* isolate can be done by

inoculating the organism into a

Doctors have several options for treating patients with anthrax, including antibiotics and antitoxin. Patients with serious cases of anthrax will need to be hospitalized. They may require aggressive treatment, such as continuous fluid drainage and help breathing through mechanical ventilation.

**Antibiotics**

All types of anthrax infection can be treated with antibiotics, including intravenous antibiotics (medicine given through the vein). If someone has symptoms of anthrax, it’s important to get medical care as quickly as possible to have the best chances of a full recovery. Doctors will select antibiotics that are best for treating anthrax and that are best for the patient based on their medical history.

**Antitoxin**

When anthrax spores get inside the body, they can be “activated.” When they become active, anthrax bacteria can multiply, spread out in the body, and produce toxins—or poisons. Anthrax toxins in the body cause severe illness.

After anthrax toxins have been released in the body, one possible treatment is antitoxin. Antitoxins target anthrax toxins in the body. Doctors must use antitoxin together with other treatment options.

Currently, there are a few types of antitoxins that can be used for treating anthrax