The Genus Bacillus

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Bacillus spp. Are:

- Spore-forming,

-Aerobic,
-Gram-positive rods

-Inhabit soil and water

-The pathogen of vertebrates, including humans, is B. anthracis

-B. cereus causes canine and human food poisoning

- **Morphology and Staining**

-Cells of B. anthracis are gram-positive,

-Nonmotile.

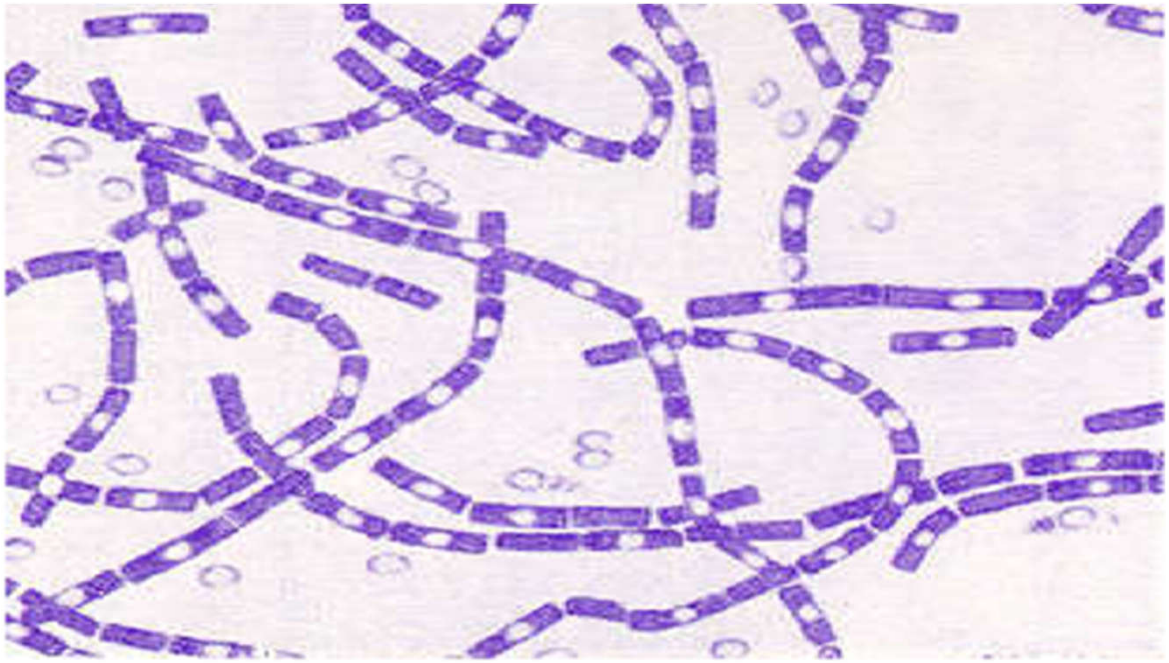
-Roughly rectangular rods with square ends

-Chains are common.

-Spores within the cell cause no swelling.

-A capsule is formed in vivo.

Bacillus anthracis Gram stain, the cells have characteristic squared ends.



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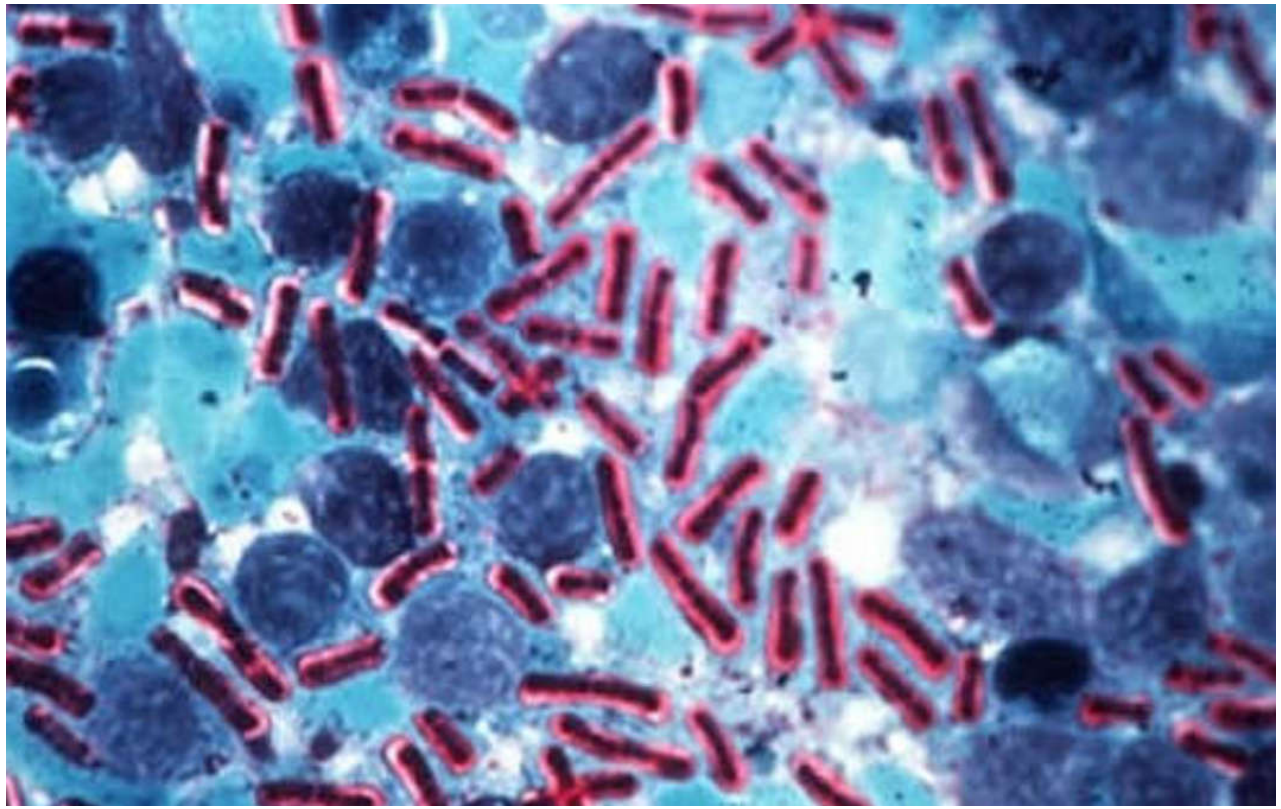
Bacillus anthracis, methylene blue stain



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Growth Characteristics

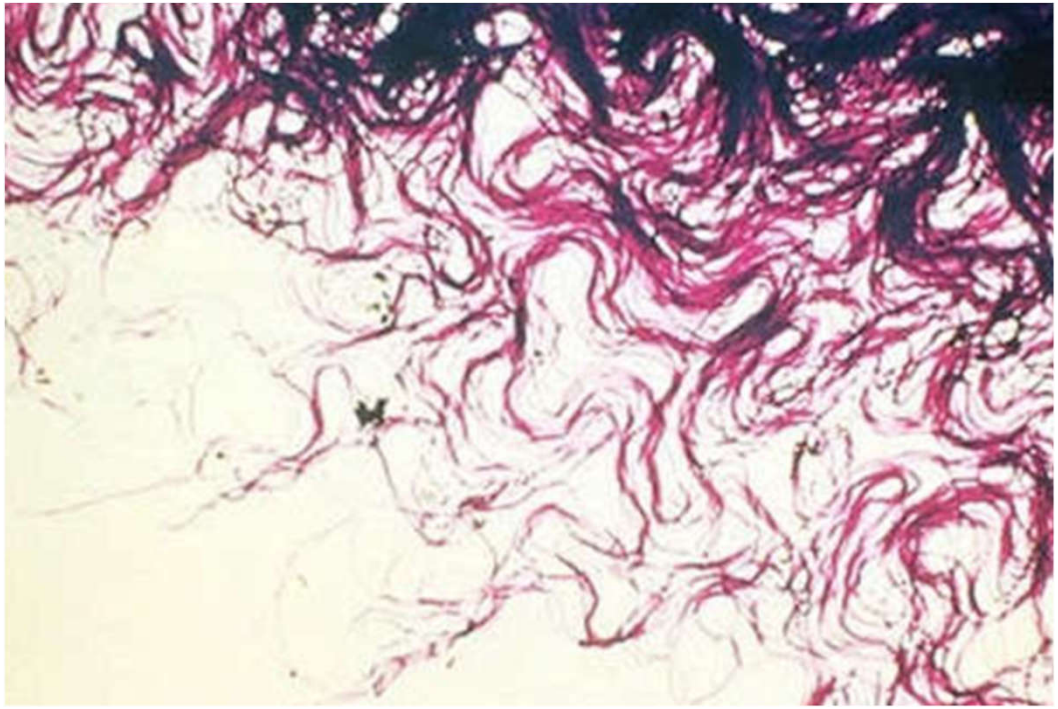
- A facultative anaerobe,

-Colonies grown in air have a dull surface and wavy margin formed by strands of bacterial chains ("medusa-head").

- Colonies grown in greater than 20% carbon dioxide on serum agar containing 0.7% bicarbonate are mucoid and consist of encapsulated bacteria.
- Sporulation occurs under abundant oxygen and never in vivo.

Bacillus anthracis, medusa head morphology

Bacillus anthracis, medusa head morphology



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Cellular Products of Medical Interest

Plasmid (pX01) encodes a protein toxin with three components:

- Edema factor is a calmodulin dependent adenylate cyclase, which raises cellular cAMP levels, causing electrolyte and fluid loss.

-Lethal factor causes release of large amounts of IL-1 from macrophages, it is cytotoxic and triggers apoptosis of this cell type.

-The protective fraction is required for activity of the other factors.

- Hemolysin affects goat, sheep, and rabbit erythrocytes.

Resistance

- spores can persist for decades in a stable, dry environment.
-Spores are killed by autoclaving (121 °C/ 15 min) and dry heat (150 °C/60min).

-Spores are not highly susceptible to phenolic, alcoholic, and quaternary ammonium disinfectants.

-Aldehydes, oxidizing and chlorinating disinfectants, betapropiolactone, and ethylene oxide are more useful.

-Heat fixation of smears does not kill spores.

ECOLOGY

Reservoir

-The soil is the source of anthrax infection for herbivores.

-Other species are exposed via infected animals and animal products.

Transmission

Infection takes place by:

- Ingestion of contaminated feed or water

-Wound infection and arthropod bites.

Human infections occur via:

- Skin wounds (malignant carbuncle),

-Inhalation ("wool-sorter's disease") and,
- Ingestion.

LABORATORY DIAGNOSIS

Sample Collection

During sample collection, precautions against contamination of the environment are important.

-Blood may be aspirated from a superficial vessel.

- For direct examination, bloody discharges from orifices are sampled.

Direct Examination

- Blood and organ smears are stained by Gram stain

- Capsule stain such as McFadyean's methylene blue.

Isolation and Identification
- *Bacillus anthracis* grows on all common media.

Definitive identification is by:

-Specific bacteriophage (gamma phage).

-Fluorescent antibody technique.

- **Immunodiagnosis**
  - *Bacillus anthracis* antigens can be demonstrated in extracts of contaminated products by a precipitation test using high-titered antiserum (Ascoli test).

- **Molecular biological methods**

-DNA probes and PCR have been designed to detect specific sequences on DNA found in pX01, pX02, and the chromosome of *B. anthracis*.