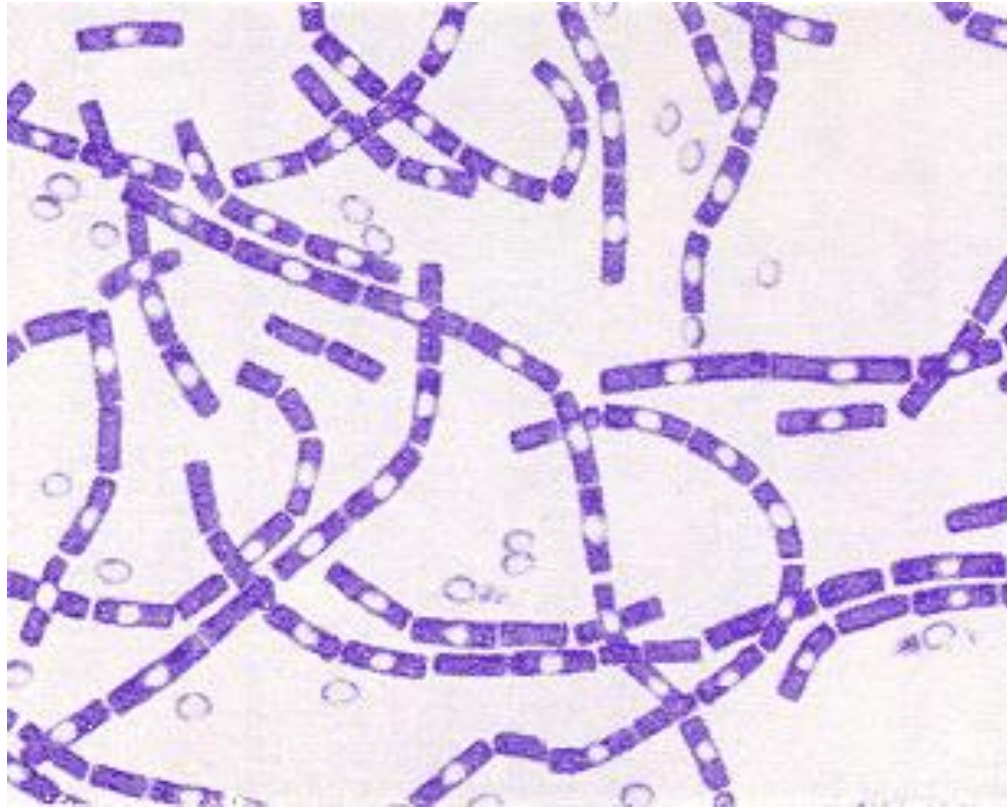


Bacilli

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<https://www.google.com/search?q=bacillus+anthracis&sxsrf=>

General Characteristics:

- Bacilli are rod shaped gram positive, aerobe or facultative anaerobe, spore forming bacteria
- They are catalase positive
- Except *B. anthracis* and *B. mycoides*, all other members of the genus are motile
- Cells occur singly or in chain of rod shaped organisms
- The genus *Bacillus* encompasses almost 70 species

Important species:

- *Bacillus anthracis*
- *Bacillus cereus*,
- *Bacillus subtilis*,
- *Bacillus licheniformis*,
- *Bacillus mycoides*,
- *Bacillus thuringiensis*

General Characteristics:

- Bacilli species are ubiquitous, present in soil, water and food products
- They are the most common laboratory contaminant.
- **Bacilli differ from Clostridium**
 - Clostridia are strict anaerobes or aerotolerant
 - Catalase negative
 - Clostridia spores are of bulging type

Cultural characteristics:

- Bacilli grow well on blood agar and nutrient agar
- *Bacillus anthracis* forms flat, dry, greyish colonies of upto 5mm size with characteristic “*ground glass appearance*”.
- The hairy curled outgrowth from the colony appears like “*medusa head*”
(*observed under low magnification*)
- The colonies are non- haemolytic

Cultural characteristics:

- *B. anthracis* produce capsule and forms mucoid colonies
(when grown on nutrient agar containing 0.7% sodium bicarbonate and incubated under 5-20% CO₂)
- The colonies of *B. cereus* are similar to that of *Bacillus anthracis* and haemolytic.
- The colonies of *B. licheniformis* have resemblance with lichen - becomes brown upon ageing

***Bacillus anthracis* Vs anthracoid organisms**

Characteristics	Anthrax bacilli	Anthracooids
Motility	Non-motile	Motile
Shape	Blunt ended – square shaped Bamboo stick appearance	Round end
Hemolysis	Hemolysis absent or weak.	Usually well marked
Capsule	Capsulated	Non-capsulated
Medusa head colony	Present	Not present
Growth in Penicillin Agar (10 units/ml)	No Growth	Grow Usually
Gelatin Liquefaction	Slow Liquefaction	Rapid Liquefaction
Gamma Phage	Susceptible to gamma phage	Not susceptible
Pathogenesis	Pathogenic to laboratory animals	Not pathogenic

Anthrax

Anthrax

- The most pathogenic species is *B. anthracis*
- Causes highly fatal septicaemic disease in animals and man
- The course of disease is very rapid
- Sudden death in group of animals without premonitory sign and symptoms

Epidemiology

- Anthrax is primarily a disease of herbivores
- Different species vary markedly in their susceptibility to anthrax bacilli
- **Ruminants are highly susceptible**
- Pigs and horses are considered moderately susceptible whereas carnivores are relatively resistant.
- Owing to high body temperature, birds are considered refractory to this organism

Anthrax Spore:

- Vegetative forms of bacilli in environmental oxygen get transformed into “spores”
- Spores are metabolically inactive and maintains themselves in the environment for years.
- Alkaline soil, high nitrogen content and calcium and moisture - support germination of spores
- Outbreaks occur following grazing over pasture contaminated with spores due to flooding, excavation or activity of earthworms

Anthrax Spore:

- Spores are quite resistant to environmental conditions
- Claimed to survive up to 200 years
- Spores are the main infective form acquired through ingestion
- When vegetative forms of bacteria are exposed to environmental oxygen they form spores
- PM examination is not advised on suspected cases
(as it may facilitate sporulation and thereby contaminate environment).

Pathogenesis:

- Infection acquired by **ingestion** of spore.
- Spores entry through **inhalation** is also possible.
- In some hosts, spore may enter through **cut or abrasion** in the skin leading to cutaneous lesions.
- Sometimes, they may gain entry to blood circulation and lead to fatal septicaemic conditions

Pathogenesis:

- The two principal virulence factors of *Bacillus anthracis* are tripartite toxin and its poly- D-glutamic acid capsule.
- Both these virulence factors are plasmid coded.
- The **tripartite toxin** is being coded by large (182kb) plasmid **pOX01** whereas,
- **Polypeptide capsule** is coded by smaller (95kb) plasmid **pOX02**
(Dogonay, 2017)
- Components of tripartite toxin of *Bacillus anthracis* are:
 - **Oedema factor (EF)**
 - **Protective antigen (PA) and**
 - **Lethal factor (LF)**

Protective Antigen:

- PA is the receptor binding sub-unit for EF and LF
- PA is essential for entry of toxins within the cell
- EF combines with PA to form *oedema toxin*
- LF combines with PA to form *lethal toxin*
- PA help EF and LF to be transported to intra-cellular locations to exert their effect

Sign and symptoms:

- Anthrax is most commonly observed as peracute and acute form
- Ch / by sudden death without apparent clinical signs and symptoms
- The blood may come in urine and oozing of tarry coloured fluid from rectum and other natural orifices is generally observed from carcass.
- The course of disease is rapid in susceptible species whereas more protracted course is observed in animals exhibiting lower susceptibility.
- Acute cases ch/by fever, muscle tremor and difficulty in breathing
- Animal may die within 2-3 days
- *Splenomegaly* is a common finding, in case PM examination is performed

Sign and symptoms:

- Sub acute forms is characterised by fever, depression, inappetence, prostration and death
- In some animals, swelling in throat region is observed.
- Horses may exhibit signs of digestive upset and colic.
- Pig population exhibit greater resistance to anthrax bacilli
- Symptoms mainly observed are swelling of the throat and pharyngeal and cervical lymph glands.
- Intestinal form of the disease in pigs is ch/by with anorexia, vomiting, diarrhoea (*sometimes bloody*) or constipation.

Diagnosis:

- Per acute death with oozing of tarry coloured blood from nature orifices (mouth, nostril, anus etc.) should be suspected anthrax.
- Carcass do not exhibit signs of rigor mortis and putrefy rapidly.
- Polychrome methylene blue staining of smear prepared from peripheral blood reveal presence of blue square ended long chains of bacilli, surrounded by pink capsule
- This unique staining characteristic is termed as “*Macfaden reaction*”.

Diagnosis:

Ascolis test:

- Performed on samples like **hide**
- The homogenised material is boiled and filtered to be used as antigen in this reaction.
- The filtrate is layer over specific antisera kept in a narrow tube
- In positive case, white precipitin line appears between the antigen and antisera
- PCR methods have been developed to detect cases of anthrax

Treatment and Control:

- Penicillin in large doses can be used to treat the affected animals.
- PM examination is prohibited on suspected carcass
(*as exposure to oxygen promotes sporulation*)
- Deep and safe burial of carcass should be ensures.
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- In endemic areas, routine and mass vaccination of susceptible population should be followed.
- ***Sterne strain live spore vaccine*** is recommended
(*non-capsulated avirulent strain*)
- **Sporicidal disinfectant should be used**
Eg- 5% formalin
3% peracetic acid etc

Anthrax in Human

- Anthrax cases human are seen after occupation exposure or consumption of contaminated carcass.
- Three clinical presentations -depends upon the route of entry of spores
 - through skin,
 - by ingestion or
 - by inhalation
- The cutaneous form of anthrax is the most common and least severe form.
- Entry of spores through abrasion or cut skin may lead to localised lesion *i.e.* large boil or sore covered by black scab

Anthrax in Human

- Infection through inhalation of spore exhibit most severe *pulmonary form of the disease*
- Ch/ by haemorrhagic pneumonia and associated pleural effusion (*Wool sorters disease*)
- The initial symptoms are of high fever and difficulty in breathing. Pulmonary anthrax is often fatal.
- Gastro-intestinal form is observed following ingestion of spores, usually after eating of infected undercooked meat.
- The symptoms of *intestinal form of anthrax* are fever, abdominal pain, bloody diarrhoea and vomiting with blood.

Bacillus licheniformis

- *B. licheniformis* is widely distributed in environment
- Important organism associated with food spoilage.
- Recognised as a cause of abortion in late pregnancy in cattle.
- Feeding of silage and mouldy hay has been reported as an associated factor.
- *Necrotizing placentitis* and *fetal multifocal suppurative bronchopneumonia* is observed.

Bacillus cereus:

- *Bacillus cereus* has been implicated in cases of:
 - food poisoning in human,
 - wound infections and
 - sometimes in mastitis
- *Bacillus cereus* grows on wide variety of foods producing heat resistant toxins.
- Consumption of such food may lead into **self limiting poisoning** in human characterised by vomiting and diarrhoea
- *B. cereus* mastitis in cattle is characterised by very high somatic cell counts, though the number of cases are negligible.

THE END

The images for slides are taken from resources available on internet and used for the purpose of teaching students