BIOLOGY

Gram positive Bacilli
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Clinically important Gram positive bacilli

Spore forming
1. Bacillus
2. Clostridium

Non spore forming
1. Corynebacterium
2. Listeria
3. Lactobacillus

Bacilli / branching filaments
1. Actinomyces
2. Nocardia
Spore-forming Bacilli

Genus Bacillus
Genus Clostridium
General Characteristics of the Genus *Bacillus*

- Gram-positive, endospore-forming. Spores seen after several days of incubation, but not typically in fresh clinical specimens.
- Motile rods
- Large (0.5 x 1.2 to 2.5 x 10) μm
- Mostly saprophytic
- Aerobic or facultatively anaerobic
- Catalase positive (mostly)
Bacillus spp. are ubiquitous

- Soil, water, and airborne dust, the primary source is the soil

Most are saprophytic and are isolated as contaminants,

Bacillus anthracis is a major pathogen

- Others are opportunists
Spores are produced when the bacteria get stressed (i.e. drying, temp.)

Heat shock (heat to 56°C) will induce spore formation

On gram stain, appear as clear areas within the bacterial cell

Spores aid in the survival of the bacteria
Significant *Bacillus* Species

**Bacillus anthracis**
- Agent of anthrax, a disease in livestock
- Humans acquire infection by contamination of wound or ingestion or inhalation of spores

**Bacillus cereus**
- transmission through traumatic introduction, contaminated medical equipment, or ingestion of contaminated food
- Causes food poisoning, frequently from left-over rice
- An opportunist

**Bacillus subtilis**
- Common laboratory contaminant
Bacillus anthracis

- Large, block-shaped rods
- Central spores that develop under all conditions except in the living body
- Virulence factors – polypeptide capsule (antiphagocytic) and exotoxins (that mediate tissue destruction)
- 3 types of anthrax:
  - **cutaneous** – spores enter through skin
  - **pulmonary** – inhalation of spores
  - **gastrointestinal** – ingested spores
Laboratory Diagnosis: *Bacillus anthracs*

- *B. anthracis* in a gram stain from a cutaneous lesion
Bacillus anthracis: Clinical Infections in Humans

- Cutaneous anthrax
b. *Bacillus cereus*

- Large, motile, saprophytic bacillus
- Heat resistant spores
- Pre-formed heat and acid stable toxin (Emetic syndrome)
- Heat labile enterotoxin (Diarrhoeal disease)

Infections in the immunosuppressed hosts
- Opportunistic infections of the eye
- Meningitis, bacteremia, septicemia, and osteomyelitis
- Diarrheal and emetic food poisoning
B. cereus

Food poisoning (can be cultured from stool or vomitus)

- **Diarrheal syndrome**
  - Associated with meat, poultry, and soups
  - Incubation period of 8 to 16 hours
  - Fever uncommon
  - Resolves within 24 hours

- **Emetic form**
  - Associated with fried rice
  - Abdominal cramps and vomiting
  - Incubation period of 1 to 5 hours
  - Resolves in 9 hours
Aya Emad el deen
The Genus *Clostridium*

- Gram-positive, spore-forming rods
- Anaerobic and catalase negative
- 120 species
- Oval or spherical spores produced only under anaerobic conditions, Diameter of the spore is larger than the cell resemble a spindle
- Synthesize organic acids, alcohols, and exotoxins
- Cause wound infections, tissue infections, and food intoxications
Gas Gangrene

- *Clostridium perfringens* most frequent clostridia involved in soft tissue and wound infections - myonecrosis
- Spores found in soil, human skin, intestine, and vagina
- Predisposing factors – surgical incisions, compound fractures, diabetic ulcers, septic abortions, puncture wounds, gunshot wounds
Tetanus

*Clostridium tetani*

Common resident of soil and GI tracts of animals
- Agricultural workers and gardeners and are more prone because the spores are present in the soil.
- At birth under unhygienic conditions baby’s can get – *tetanus neonatorum.*

Causes tetanus or lockjaw, a neuromuscular disease
Most commonly among geriatric patients and IV drug abusers; neonates in developing countries
Spores usually enter through accidental puncture wounds, burns, umbilical stumps, frostbite, and crushed body parts.

Anaerobic environment is ideal for vegetative cells to grow and release toxin.

Drum stick appearance

Motile with peritrichous flagella

Obligatory anaerobes

**Tetanospasmin** – neurotoxin causes paralysis by binding to motor nerve endings; blocking the release of neurotransmitter for muscular contraction inhibition; muscles contract uncontrollably

Death most often due to paralysis of respiratory muscles
GABA
GLYCINE
Aya Nabeel
Clostridial Food Poisoning

- *Clostridium botulinum* – rare but severe intoxication usually from home canned food
- *Clostridium perfringens* – mild intestinal illness; second most common form of food poisoning worldwide
Botulism – intoxication associated with inadequate food preservation

*Clostridium botulinum* – spore-forming anaerobe; commonly inhabits soil and water

Infant botulism – caused by ingested spores that germinate and release toxin; flaccid paralysis

Wound botulism – spores enter wound and cause food poisoning symptoms
Spores are present on food when gathered and processed.
If reliable temperature and pressure are not achieved, air will be evacuated but spores will remain.
Anaerobic conditions favor spore germination and vegetative growth.
Potent toxin, **botulin**, is released.
Toxin is carried to neuromuscular junctions and blocks the release of acetylcholine, necessary for muscle contraction to occur.
Double or blurred vision, difficulty swallowing, neuromuscular symptoms
Medically important:

- *Listeria monocytogenes*
Listeria monocytogenes

- Non-spore-forming Gram-positive
- Ranging from coccobacilli to long filaments
- 1-4 flagella
- No capsules
- Resistant to cold, heat, salt, pH extremes and bile
- Virulence attributed to ability to replicate in the cytoplasm of cells after inducing phagocytosis; avoids humoral immune system
- a. Can be normal GI flora, found in the environment, as well as animals
- b. transmission through ingestion of contaminated food (meat and dairy); also mother to fetus in colonized moms

- Primary reservoir is soil and water; animal intestines
- Can contaminate foods and grow during refrigeration
- **Listeriosis** - most cases associated with dairy products, poultry, and meat
- Often mild or subclinical in normal adults
- Immunocompromised patients, fetuses and neonates; affects brain and meninges
  - 20% death rate
Listeria sp. on Gram stain

http://www.geocities.com/CapeCanaveral/3504/gallery.htm
Aya Abdulkareem
Gram-Positive Irregular Non-Spore-Forming Bacilli

Medically important genera:
- *Corynebacterium*
- *Propionibacterium*
- *Mycobacterium*
- *Actinomyces*
- *Nocardia*
Pleomorphic; stain unevenly
20 genera; *Corynebacterium*, *Mycobacterium*, and *Nocardia* greatest clinical significance
All produce catalase, possess mycolic acids, and a unique peptidoglycan.
Genus *Mycobacterium*

- Gram-positive irregular bacilli
- Acid-fast staining
- Strict aerobes
- Produce catalase
- Possess mycolic acids and a unique type of peptidoglycan
- Do not form capsules, flagella or spores
- Grow slowly
Mycobacterium tuberculosis

- Tubercle bacillus
- Produces no exotoxins or enzymes that contribute to infectiousness
- Virulence factors - contain complex waxes and cord factor that prevent destruction by lysosomes or macrophages
Aya Hafith
**Corynebacterium diptheriae**

- Gram-positive irregular bacilli
  - Causes localized inflammation (pseudomembrane, grayish white exudate) and generalized toxaemia
- Gram/+ve/palisade/Chineseletter arrangement
- Irregular swellings at one end - club shaped
- Corynebacteria tend to Pleomorphic in microscopic and colonial morphology.
  - diphtherotoxin – exotoxin
    - 2 part toxin – part B binds and induces endocytosis; part A arrests protein synthesis
      - a. normal URT and skin flora; also NF of animals
      - b. person to person or endogenous
Stained *Corynebacterium* cells. The "barred" appearance is due to the presence of polyphosphate inclusions called metachromatic granules. Note also the characteristic "Chinese-letter" arrangement of cells.
• diphtherotoxin – exotoxin
  • 2 part toxin – part B binds and induces endocytosis; part A arrests protein synthesis
  • a. normal URT and skin flora; also NF of animals
  • b. person to person or endogenous

• a. *C. diptheriae*
  • i. diphtheria toxin: exotoxin that destroys cells
    • Respiratory diphth: pseudomembrane exudates; respir compromise; toxin affects organs
    • Cutaneous: non-healing ulcers
  • b. *C. jeikeium*
    • i. resistance to multiple antibiotics
    • ii. septicemia, wound infections
Reservoir of healthy carriers; potential for diphtheria is always present
Most cases occur in non-immunized children living in crowded, unsanitary conditions.
Acquired via respiratory droplets from carriers or actively infected individuals

2 stages of disease:
1. Local infection – upper respiratory tract inflammation
   - sore throat, nausea, vomiting, swollen lymph nodes; pseudomembrane formation can cause asphyxiation
2. Diptherotoxin production and toxemia
   - target organs primarily heart and nerves
Types of Diphtheria

- Faucial
- Laryngeal
- Nasal
- Conjunctival
- Vulvovaginal
- Otitic
- Cutaneous around the mouth and the nose
Aya Raid
Aerobic Actinomycetes

- Genera *Actinomyces* & *Nocardia* are nonmotile filamentous bacteria related to mycobacteria. Branching, filamentous, gram-positive rods. Some are partially acid-fast. Difficult to recognize clinically and difficult to isolate *Nocardia, Streptomyces, Rhodococcus, Tsukamurella*.
- May cause chronic infection of skin and soft tissues.
- *Actinomyces israelii* – responsible for diseases of the oral cavity, thoracic or intestines - actinomycoses.
- *Nocardia brasiliensis* causes pulmonary disease similar to TB.
Nocardia asteroides

- Branched, strictly aerobic bacillus
- Environmental saprophytes (exogenous infection)
- Lightly acid-fast
- Uncommon causes of opportunistic pulmonary disease
- Causes primary post-traumatic or post-inoculation lung disease
  - a. World-wide inhabitants of soil and water, responsible for decomposition of plant material
  - b. Can be colonizers or cause infection following traumatic inoculation or inhalation
  - c. Intracellular pathogens, prevent destruction in phagocytes, tropism for neural tissue
a. Immune competent: skin infections
   i. Mycetoma
   ii. Lymphocutaneous
   iii. Skin abscesses or cellulitis

b. Immune compromised: pulmonary and disseminated
   
i. pulmonary disease is non-specific, so risk factors add it to differential
   
ii. organism can spread hematogenously from primary site, resulting in brain and/or skin lesions (dissemination = poor prognosis)
Gram stain of *Nocardia*

Actinomyces israelii

- Has branching filaments
- Facultative anaerobes
- Normal flora of oral cavity
- Causes ‘Actinomycosis’ characterized by multiple abscess and granuloma formation
- Tissue destruction, fibrosis and sinus formation
ACTINOMYCOsis
Thank you