Bacillus Species:

- **Aerobic** gram positive **spore forming** rods
- **B Cereus -> food poisoning**
- B anthracis [anthrax] -> cutaneous (malignant pustules over the skin), inhalation, ingestion (GI anthrax, very rare)
- B thuringiensis -> useful for research purposes

Bacillus Cereus:

- Causes **food poisoning** and endocarditis, meningitis, osteomyelitis, pneumonia, eye infection [Mainly in immunodeficient patients and those with prosthetic medical devices]
- **Enterotoxins** Two types:

1- vomiting type [cerulide] – **heat stable [they survive flash frying]**, incubation period ½ hour, nausea, **vomiting**, abdominal cramps, sometimes diarrhea, connected with chines food especially ***rice and cereals***, it's formed outside the body

2- diarrheal type – **heat labile,** longer incubation period**, diarrhea** and abdominal cramps, sometimes nausea and vomiting, connected with contaminated ***meat, vegetables and sauces,*** it's formed inside the colon

- **Diagnosis**: Clinical grounds , specimen from the suspect food
- **treatment and prevention**: self- limiting, antimicrobial therapy is NOT normally required
  1- vital signs [respiratory and heart rate, temperature, blood pressure]
  2- dehydration signs
  3- fluid and electrolytes replacement

B Cereus	B. Anthracis
Motile	Non motile
Has no capsule -> has no vaccine	Has capsule, main component D- glutamic acid -> Has vaccine
Beta hemolysis	No hemolysis
produce alpha toxin [licithenase]	Doesn't produce alpha toxin
Resistance to penicillin and cephalosporins	Sensitive to penicillin and cephalosporins
Large feathery white colonies	Medusa-head colonies

Clostridium species

- **Most species of clostridia** are motile and possess peritrichous flagella
- **Anaerobes**, gram positive, **spore forming** rods

1- Clostridium tetani – tetanus, rigid paralysis [hyper-tone]

2- **Clostridium botulinum** – botulism, flaccid paralysis [hypo-tone], most common in infants [floppy baby syndrome]

3- **Clostridium perfringens** – gas gangrene + food poisoning

4- **Clostridium difficile** – pseudomembranous colitis <- antibiotics associated diarrhea

Clostridium botulinum:

-Botulism is characterized by symmetrical, **descending**, flaccid paralysis of motor and autonomic nerves usually **beginning with cranial nerves**

-Botulinum toxin: Highly toxic neurotoxin, Seven Serotypes (A-G), most important in human **A + B + E**, Absorbed by gut, carried by blood -> peripheral nerve synapses -> blocks release of Ach at the myo-neuronal junction -> reversible *flaccid paralysis*

- **There are four clinical categories of botulism:**

1- foodborne botulism = adults botulism, toxin is formed outside the body

2- wound botulism

3- infant botulism = Most common food vehicle is **honey** containing spores that germinate inside the body

4- inadvertent, following botulinum IM toxin injection

S & S:

- Initial symptoms can include nausea, vomiting, abdominal cramps or diarrhea -> Dry mouth, blurred vision, and diplopia are usually the earliest neurologic symptoms -> They are followed by inability to swallow, and speech difficulty -> In severe cases, extensive respiratory muscle paralysis leads to ventilatory failure
- The infants poor feeding, weakness, and signs of paralysis (floppy baby)
- **Infant botulism may be one of the causes of sudden infant death syndrome**

Diagnosis:

- Clinical ground
- **Toxin** may be found by ELISAs and PCR
- Mouse bioassay is the test of choice for the confirmation of botulism “gold standard”

Treatment

- Supportive treatment, especially adequate mechanical ventilation
- Antitoxin: trivalent (A, B, E)
- ***NO antibiotics***

Prevention and control:

- **Canned food** must be sufficiently heated to ensure destruction of spores [boiled for more than 20 minutes]
- No honey for the first year infants

Clostridium perfringens:

- gram positive, spore-forming rods **[don't show spores in lab cultures], non-motile**
- Anaerobic: "***stormy fermentation***" in milk media
- Double zone of hemolysis [alpha and beta hemolysis]
- Transmission: food borne, traumatic implantation
- Produce gas, crepitation, foul-smelling discharge
- Alpha toxin= licithenase, theta toxin = necrotizing toxin, epsilon toxin = edema factor, **enterotoxin = causes food poisoning last only 1-2 days [self improvement]**

Diagnostic Laboratory Tests

1- gram stain

2- thioglycolate medium + blood agar plates incubated anaerobically

3- **Nagler test**: toxin production and neutralization by specific anti-toxin

Treatment and prevention

1- surgical debridement

2- Administration of antimicrobial drugs

3- antitoxins are available

4- Food poisoning usually requires only symptomatic care

extra note: C. perfringens is one of the causes of endometritis

Clostridium difficile:

- colonizes the intestine of 50% of healthy neonates and 4% of healthy adults
- antibiotic associated diarrhea [long lasting] [Mild to moderate] : **cephalosporins** + **clindamycin**.
- Pseudomembranous colitis [severe forms] / fulminant colitis : medical emergency → toxic mega colon
- Infection may be **endogenous** [This is due to suppression of the normal bowel flora and subsequent overgrowth of C. difficile] or **exogenous** [ingestion of environmental spores]
- Produces two major toxins: Toxin A (enterotoxin) and Toxin B (cytotoxin)
- Toxin A induces cytokine production with hypersecretion of fluid
- Toxin B induces depolymerization of actin with loss of cytoskeleton
- **Hypervirulent strains** are now recognize **027 + 078**
- **Most common cause of diarrhea associated with hospitals**

Diagnosis

1- diarrhea

2- toxin A or toxin B detected in the stool

3- pseudo-membranes seen in the colon

Treatment

1- discontinue other antibiotics therapy

2- **oral** administration of ***vancomycin or metronidazole***

3- **limited-spectrum drugs** should be considered first

4- autoclave bed bans (treatment kills spores)

5- fecal transplantation