

# Anaerobic bacteria

Murray P.R. et al. Medical Microbiology. 8th edition. Elsevier, 2016

# Anaerobes

- **predominant components of the skin and mucous membranes of physiological normal flora**
- **infections of endogenous origin or exogenous origin**
- **mixed infections**
- **exsudate, pus, abscess formation, putrid odor**
- **collection, transport, laboratory diagnosis under the anaerobic conditions**

# ANAEROBIC BACTERIA

- |   |                                 |
|---|---------------------------------|
| • <i>G+ cocci</i>                           | <i>polymicrobial</i>            |
| • <i>G- cocci</i>                           | <i>endogenous</i>               |
| • <i>G- rods</i>                            | <i>mixed</i>                    |
| • <b><i>G+ rods – non-spore-forming</i></b> | <i>opportunistic pathogenic</i> |

- **spore-forming** - pathogens, clinical syndromes

# I. ANAEROBIC G+ BACTERIA

## Ia. anaerobic G+ cocci

Genera: *Peptostreptococcus*, *Peptococcus*, *Sarcinia*,  
*Coprococcus*, *Ruminococcus*

## Ib. anaerobic nonspore-forming G+ rods

Genera: *Actinomyces*, *Propionibacterium*, *Mobiluncus*,  
*Bifidobacterium*, *Eubacterium*, *Lactobacillus*, *Rothia*

## Ic. anaerobic spore-forming G+ rods

Genera: *Clostridium*

# II. ANAEROBIC G- BACTERIA

## IIa. anaerobic G- cocci

Genera: *Veillonella*, *Megasphaera*, *Acidaminococcus*

## IIb. anaerobic G- rods

Genera: *Bacteroides*, *Prevotella*, *Porphyromonas*,  
*Fusobacterium*, *Bilophila*, *Leptotrichia*, *Wolinella*

# Anaerobic spore-forming G+ rods

**GENUS:** *Clostridium*

# Anaerobic spore-forming G+ rods

## *Clostridium*

- more than 100 species
- most are **obligatory (strict) anaerobic**
- clostridia are **ubiquitous** – in soil, water, and sewage and are part of the normal microbial population in the GIT of animals and humans
- most clostridia are harmless saprophytes, but some are well-recognized **human pathogens** causing diseases such as **food poisoning** (*C. perfringens*), **diarrhea and colitis** (*C. difficile*), **tetanus** (*C. tetani*), **botulism** (*C. botulinum*), **myonecrosis – gas gangrene** (*C. perfringens*)

# Anaerobic spore-forming G+ rods

## *Clostridium*

- **virulence factors:** (1) ability to survive adverse environmental conditions through spore formation, (2) rapid growth in a nutritionally enriched, oxygen-deprived environment, and (3) production of numerous histolytic toxins, enterotoxins, and neurotoxins



# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium difficile*

### epidemiology

- is a part of the normal intestinal flora in a small number of healthy people and hospitalized patients – opportunistic pathogen
- the disease develops in people taking antibiotics
- the disease occurs if the bacteria proliferate in the colon and produce their toxins

# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium difficile*

## pathogenesis and immunity

### Virulence factors:

- **enterotoxin** (exotoxin A)
- **cytotoxin** (exotoxin B)
  
- **bacterial surface layer proteins**

# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium difficile*

## clinical diseases

- responsible for ATB associated gastrointestinal diseases from **benign diarrhea** to **life threatening pseudomembranous colitis**
- **life threatening pseudomembranous colitis**
- the most commonly caused by *C. difficile* of toxigenic strain TcdA/TcdB

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium difficile*

### laboratory diagnosis

- **sample** - stool
- **detection of the enterotoxin or cytotoxin in stool specimen** or detection of *C. difficile* toxin genes by nucleic acid amplification techniques
- **microscopy** - G+ spore-forming rods
- **anaerobic cultivation** on blood agar or selective medium – characteristic „barnyard“ smell (like horse urine)
- **colonoscopy** – evidence of pseudomembranes

# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium difficile*

## treatment

- discontinuation of the implicated antibiotic (e.g. ampicillin, clindamycin, fluoroquinolones)
- specific therapy with **metronidazole** or **vancomycin**

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium tetani*

### epidemiology

- *C. tetani* is ubiquitous – it is found in fertile soil and transiently colonizes the GI tracts of many animals
- spores present in the soil are introduced into injured tissue by deep stabbing where they germinate and produce tetanus toxin

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium tetani*

### pathogenesis and immunity

- **tetanospasmin** (A-B toxin) → inactivates proteins that regulate release of the inhibitory neurotransmitters of CNS (GABA, glycine) → resulting in **spastic paralysis**
- **tetanolysin**

# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium tetani*

**clinical diseases**

- **generalized tetanus**
- **localized tetanus**
- **neonatal tetanus (tetanus neonatorum)**
- **tetanus of drug addict**



# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium tetani*

### laboratory diagnosis

- **case history + clinical presentation**
- **microscopy** – useful but frequently unsuccessful, G+ rod with round, terminal spores that expand the body of bacteria and give it the appearance of a drumstick
- **culture** (anaerobic) – useful but frequently unsuccessful
- if the bacteria are recovered in culture, production of toxin can be confirmed with **the tetanus antitoxin neutralization test in mice** (only in public health reference laboratories)

# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium tetani*

**treatment**

- **debridement of the primary wound**
- **penicillin or metronidazole**
- **passive immunization with human tetanus antibodies (immunoglobulin - antitoxin)**
- **monitoring of vital functions, muscle relaxants...**
  
- **vaccination**

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium botulinum*

### epidemiology

- *C. botulinum* is commonly isolated in soil and water samples throughout the world
- spores contaminate food that are not well sterilized
- spores germinate in anaerobic environment of canned food and produce toxin and gas (bulging of canned food)
- toxin – one of the strongest toxins ever

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium botulinum*

### pathogenesis and immunity

- *C. botulinum* toxin is protein (A-B toxin) - inactivates the proteins that regulate release of acetylcholine, - blocking neurotransmission at peripheral cholinergic synapses - **a flaccid paralysis**
- *C. botulinum* toxin is tasteless and odorless
- intoxication occurs after ingestion of toxin or spores

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium botulinum*

### clinical diseases

- **classic or foodborne botulism**
- **infant botulism**
- **wound botulism**
- **inhalation botulism**

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium botulinum*

### laboratory diagnosis

- **case history + clinical presentation**
- **microscopy** - G+ rods with subterminal spores that expand the body of bacteria
- **anaerobic cultivation**
- **detection of toxin activity in samples of food, stool, serum - ELISA**
- **demonstration of toxin production** (at public health laboratories) – mouse bioassay

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium botulinum*

### treatment

- **ventilatory support**
- **gastric lavage and metronidazole or penicillin therapy**
- **trivalent botulinum antitoxin**
- **antitoxin** – heterologous horse serum containing the antitoxin used for passive immunization

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium perfringens*

### epidemiology

- type A *C. perfringens* commonly inhabits the intestinal tract of humans and animals and is widely distributed in nature, particularly in soil and water contaminated with feces
- spores are formed under adverse environmental conditions and can survive for prolonged periods



# Anaerobic spore-forming G+ rods

Clostridium: *Clostridium perfringens*

**pathogenesis and immunity**

- **alpha toxin**
- **beta toxin**
- **epsilon toxin**
- **iota toxin**
  
- **enterotoxin**

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium perfringens*

### clinical diseases

- **type A *C. perfringens*** – is responsible for variety of diseases including **soft-tissue infections (cellulitis, fasciitis or suppurative myositis, and myonecrosis** with gas formation in the soft tissue – gas gangrene), **food poisoning, necrotizing enteritis, and septicemia**
- **type C *C. perfringens* - necrotizing enteritis**
- **type B – E *C. perfringens*** - strains of types B through E do not survive in soil but colonize the intestinal tracts of animals and occasionally humans

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium perfringens*

### laboratory diagnosis

- **case history + clinical presentation** - gas and odor from the wound
- **microscopy** - G+rods with subterminal spores in clinical specimens, usually in the absence of leucocytes
- **anaerobic cultivation**
- **serotyping** – evidence of antigen (toxin) using reference antibodies

# Anaerobic spore-forming G+ rods

## Clostridium: *Clostridium perfringens*

### treatment

- **suppurative myonecrosis and myonecrosis** - surgical debridement and high-dose penicillin therapy, hyperbaric oxygen treatment, antitoxin
- **less serious, localized soft-tissue infections** - debridement and PNC
- **clostridial food poisoning** - oral rehydration or intravenous fluids and electrolytes

# Other Clostridial Species

- many other clostridia have been associated with clinically significant disease
- their virulence is a result of their ability to survive exposure to oxygen by forming spores and producing many diverse toxins and enzymes

# Other Clostridial Species

- *C. septicum* - an important pathogen, a cause of nontraumatic myonecrosis and often exists in patients with occult colon cancer, acute leukemia, or diabetes; it can spread into tissue and rapidly proliferate, producing gas and tissue destruction; most patients have a fulminant course, dying within 1 to 2 days after initial presentation
- *C. sordellii* - is implicated in a fatal toxic shock syndrome associated with natural childbirth or medically-induced abortions
- *C. tertium* – is associated with traumatic wound infections (e.g. war wounds, a fall producing a soil-contaminated wound)