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Bacteriology III

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Phylum *Bacteroidetes*

- G- bacilli - mainly symbionts (maybe pathogenic) in soil, water and human guts

- we observe ratio of g. *Bacteroides* and g. ***Prevotella*** in gut microbiome – involvement of diet (Western, proteins, animal fat × polysaccharides, fibre, vegetarian, Mediterranean; from fibre **SFCA –** short chain fatty acids (acetate, butyrate, propionate) - reduce appetite, reduce spontaneous food intake, reduce inflammation and influence insulin sensitivity)

Phylum *Cyanobacteria*

- G-; endosymbiotic theory – precursors of chloroplasts

- production of cyanotoxins (mainly hepatotoxicity and neurotoxicity – saxitoxin *Anabaena spp.*) - after swimming even vomiting, muscle and headache or "only" skin irritation

- plus spirulina (*Arthospira*; supplement)

Phylum *Deinococcus-Thermus*

- extremophiles, formerly known as *Hadobacteria* (gr. hades = underworld)

- very thick cell wall – stain as G+, but contain also outer membrane, so more like G-

- *Thermus aquaticus*: Taq pol (72°C optimal, up tu 95°C) - Kery Mullis used in PCR (previously addition of enzyme from *E. coli* after each cycle)

Phylum *Actinobacteria*

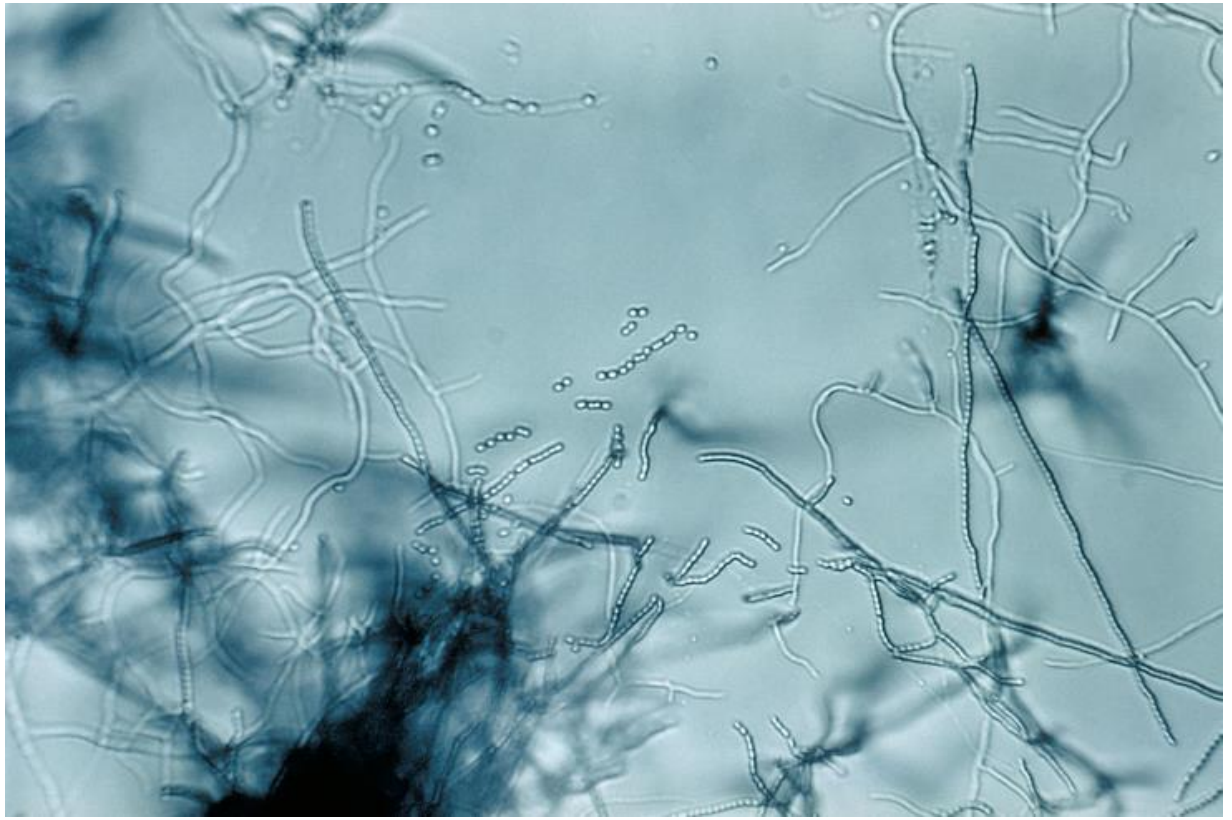
- G+ bacteria with high GC content (up to 70 %; former name)

- g. *Streptomyces* is important due to antibiotic production (neomycin, chloramphenicol, etc.)
- g. *Micrococcus*; *Corynebacterium*; *Mycobacterium* (TBC); *Bifidobacterium*;

g. *Streptomyces*

- soil bacteria, spores, aerobic and filamentous (mycelium)
- developed secondary metabolism
- disease: mycetoma - granulomatous inf. of skin
- *S. griseus* – 1943 – streptomycin (Selman Waksman and PhD. student Albert Schatz)
- antimycotics (nystatin, amphotericin B); antiparasitics (ivermectin); antineoplastics (bleomycin); inh. of β-lactamases (clavulanate)

g. *Streptomyces*



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g. *Mycobacterium*

- special type of cell wall – **no Gram stain** (neither +, nor -) - PEN resistant (mycolic acid up to C90)
- aerobic bacilli, cultivation: Löwenstein-Jensen (malachit. green, eggs), some of them carotenoid dyes (sometimes dependent on light: *M. kansasii*)
- types:

1. ***M. tuberculosis* complex** - TBC (+ *M. bovis*; att. vaccine BCG)
2. ***M. leprae*** - leprosy
3. **Nontuberculous mycobacteria** (NTM): *M. avium* – pulm. inf.; plus fast growing mycobacteria (*M. smegmatis* – non-pathogenic; cultivation 7 days × slow: 3 weeks and more..)

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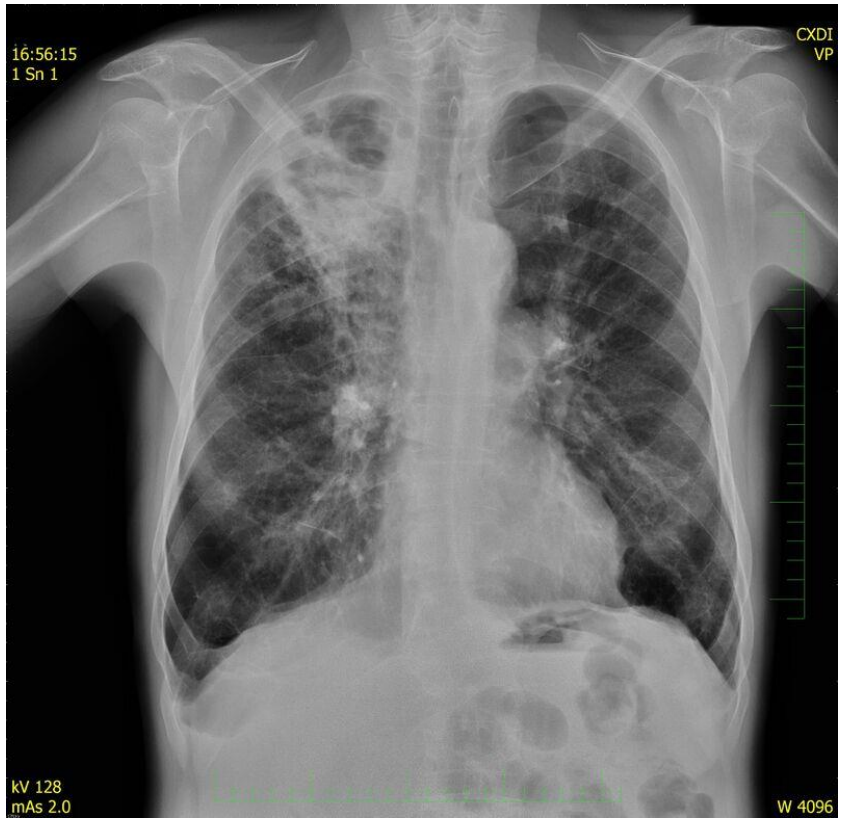
Mycobaterium tuberculosis **- TBC**

- TBC - causes: ***M. tuberculosis, bovis***, and ***africanum*** (= compl)
- vacc. of children untill 2010 comp. - Mantoux test (bud)
- proof: microscopy + staining; cultivation LJ agar in 3 weeks, PCR (but also dead ones, symptoms must be present), lungs RTG; indirect QuantiFERON® (3 tubes, blood, NC, PC, peptides)
- entry via lungs (droplets) - infection from another patient
- symptoms: **fatigue**, **anorexia**, **cough**, **hemoptase** (!!!)
- treatment: **combination of 3 drugs**, takes 6 month (monoth. leads to "**fall & rise phenomenon**")

Mycobaterium tuberculosis - TBC

- **primary TBC** – entry via lungs, exudative inflammation and pneumonia - nodules (90% healed) - **postprimary inf.** (30% reinf. exogenous; or reactivation with malnutrition, preg., alc.) - spread through blood or by coughing and swallowing of sputum - caseous necrosis
- pTBC often asympt., pp infection similarly or nonspecif. flu
- serious forms: **miliary TBC** (dissemination to body, meningitis; *milium* = millet - small nodules, RTG); **pneumonia** (chills, shiver, fever)
- most serious inf. disease in the world (20 mil. patients, 8 mil. deaths per year)

Mycobaterium tuberculosis - TBC



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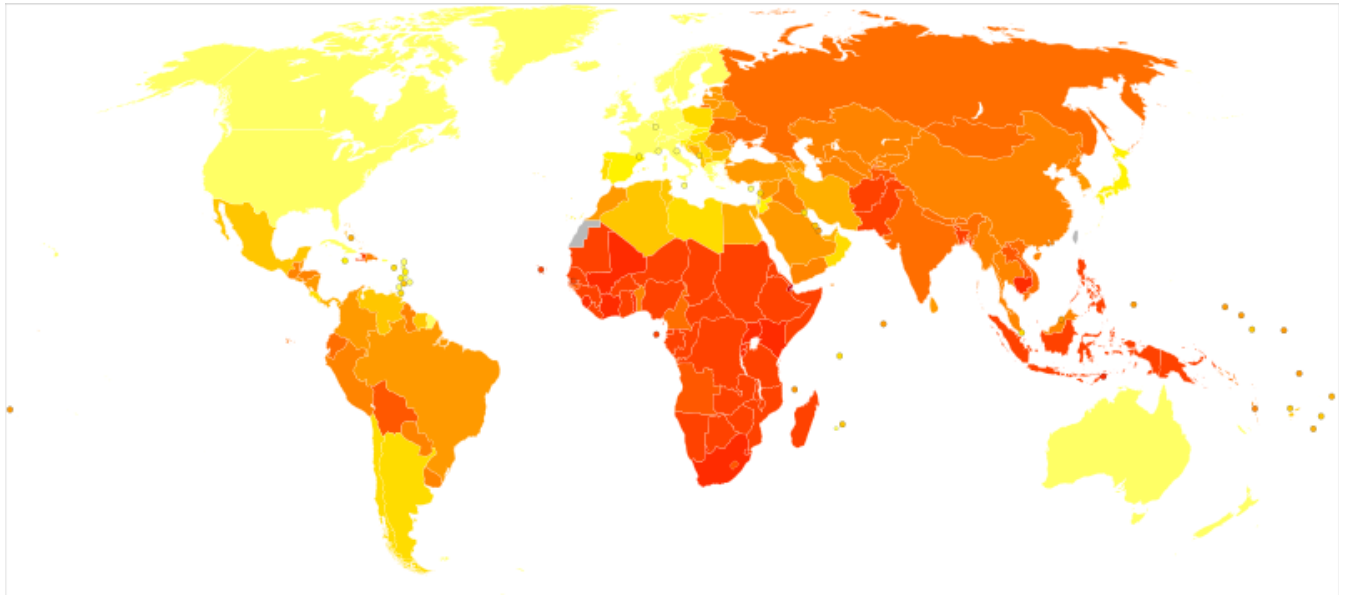

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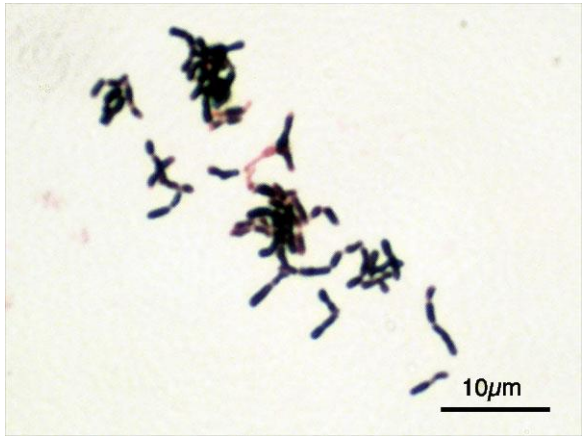
g. *Bifidobacterium*

- G+ bacteria, nonmotile and anaerobic
- common gut microbiota (mainly in newborns; breastfeed; FOS a GOS) and probiotics
- probiotics + normal therapy - e.g. in case of ulcerative colitis (improvement in frequency of remissions)
- *B. dentium*: dental caries
- branched shape: "bifid"



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Phylum *Firmicutes*

- mostly G+ bacteria; with low GC content

- lat. *firmus* = solid, firm; *cutis* = skin
- both cocci and bacilli
- gut microbiota - "fat loving" - Western fat meal

class *Clostridia* - obligatory anaerobes – *Clostridium* (bacilli; anerobic; spores)

g. *Clostridium*

- *Clostridium botulinum*: saprophyte GIT of animals, not common in men; production of neurotoxic **botulotoxin** (sausage poison) - thermolabile (boiling for 15 min.) - LD_{50} is 1 μg;
- forms in anaerobic environment - **cans** with vegetables or meat, **bee's honey** (children) - hazardous are bulgind cans, rancid taste, insufficiently heat treated
- alimentary, i.t. 6 – 72 h: toxin i nthe blood – Zn protease, lack of ACh in cleft (muscl. paresis) - *botulisms* (triad: bulbar paralysis, norm. temperature and sensitivity) - serum (antigen types) breath support
- in CZ 3 - 4 cases per year; lethality 20%

g. *Clostridium*

- *Clostridium tetani*: neurotoxin **tetanospasmin** (causes tetanus) - anaerobic, sporulation in presence of oxygen
- bacteria present in animal guts (sometimes human) - plus in soil manured with cow or horse dung
- **tetanus**: i.t. week, after injury gets into blood and to clefts (inhibition of GABA production = tonic-clonic seizures) - trismus (chew. muscles), risus sardonicus (mim. muscl., salivation) and opistotonus (bending in an arc) - after reaching breathing muscles asphyxia and death
- prevention: toxoid, every 10 years
- treatment: antitetanic immunoglobulin, breath support, decrease of irritability

g. *Clostridium*

- *Clostridium difficile*: bacteria present in 5% of population – some strains produce toxins (A and B – destruction of mucosa, depression of IS, diarrhea, fever, abdominal pain)
- cause of diarrhea or more serious **pseudomembranous colitis** (cooperation of A and B; often after ATB – clindamycin, penicilins, cefalosporins – may lead to toxic megacolon, ileus and rupture of intestines)
- th.: metronidazole, **vancomycin**, **fidaxomicin**; probiotics
- **FMT** (fecal microbial transplantation) - from healthy donor, efficiency upto 90% (but for IBD ambiguous) - nasojejunal probe, enema, endoscopy into appendix; acidores. capsule – still controversial (2015 – 2017: 450 times)

Phylum *Firmicutes*

class *Bacilli* (!) - obligatory or facultative aerobes

- g. *Bacillus* – spores
- g. *Staphylococcus*

- g. *Lactobacillus*
- g. *Streptococcus*

class *Mollicutes* – g. *Mycoplasma*

Bacillus anthracis

- cause of **anthrax** - spores: in soil, dead animals
- biggest threat for herbivores (cattle, horses, sheeps)
- entry of infection: **skin** (contact with infected animal, leather processing), **inhalation** of spores or **eating** infected meat
- **skin** form (redbrown papule, then pustula filled with pus, nodules, whole body symtoms) - **lung** (oedema, hemorrhagic inflam.) - **GIT** (rarely, hemorrhagic necrosis)
- virulence: exotoxin (LF, EF, PA; necrosis, fever, shock and death)
- th.: high doses of ATB (penicilin, streptomycin)
- mortality without therapy: skin upto 20%, lung upto 50%
- biological weapon

g. *Staphylococcus*

- G+ cocci in bunches, **catalasepositive**, fac. anaerobic

- part of common **microbiota of skin** of men and animals

- can be divided into:

1. **coagulasepositive** (*S. aureus*)
2. **coagulasenegative** (*S. epidermidis*, *saprophyticus*)

S. aureus subsp. *aureus*

- source of infection is human (25% permanent, 50% trans. hosts)
- predisposition of inf.: skin wound, burn, DM, catheter, etc.
- mostly **absceses** or phlegmonas (**pyodermia** - foliculitis, impetigo, furunkl), sepsis, endocarditis (after entering circulation) - often wound inf. **post-traumatic** and **post-operative**, osteomyelitis, artritis

- toxins: toxic shock syndrome toxin (TSST-1), exfoliatin (scalded skin sy.), hyaluronidase, enterotoxins
- 80% of strains res. to PEN = semisynt. res. PEN – but MRSA (vancomycin) - since 2002 there is VRSA

g. *Lactobacillus*

- G+ bacillus, aerotolerant anaerobic or microaerophilic
- belongs among lactate producing bacteria (fermentation)

- human microbiota: **vaginal** mucosa (estrogen – glycogen – enough nutrinets for lactobacilli, depending on cycle; low pH, production of H_2O_2 and bacteriocins – decrease e.g. candidas)
- probiotics, part of dairy products (kefir, cheeses) sauerkraut
- in mouth contribute to dental caries

g. *Streptococcus*

- G+ cocci; in strains, **catalasenegative**, facultative anaerobic
- common microbiota on human skin and mucosa
- divided accoriding to behavior on blood agar:

1. **β**-hemolytic (full): *S. pyogenes*, *agalactiae*
2. **α**-hemolytic (viridation): *S. pneumoniae*, *mutans*
3. **γ**-hemolytic (no): *S. urinalis*

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Streptococcus pyogenes

- cause of respiratory, skin and systemic infections
- group A according to Lancefield (serological grouping based on cell wall polysaccharide content – N-acetylglucosamin and rhamnose - Streptest at the doctor)
- + virulence: M-protein (adhesion), F-protein, capsule, pyrogenic toxin, streptolysin O (lysis of leukocytes) and S
- 10% hosts without symptoms; **strep pharyngitis** (cca 1/3, rest are viral; sore throat, fever, tonsilitis), **scarlet fever** (rash, *scarlatina*), **erysipelas**
- th.: mostly sensitive to PEN

g. *Streptococcus*

- *S. agalactiae*: group B; vaginal microbiota, inf. of newborns (treatment before childbirth)

- *S. pneumoniae*: diplococcus; capsule polysaccharide antigen, pneumococcal pneumonia, purulent meningitis, otitis media; th. for both: PEN

- *S. mutans*: dental caries

Class *Mollicutes*

- without cell wall (lat. *mollis* = soft)
- very small bacteria 0,2 – 0,3 μm
- *M.g.*: cca 500 genes ($0{,}5\times10^6$ bp) - vs. *E. coli* (4000; $4{,}6\times10^6$)
- parasites – disease to humans, animals and plants (dependent on host)

Mycoplasma pneumoniae: often respiratory infections (pharyngitis; atyp. pneumonia - fever, cough) - tetracyclines, macrolides (th.10 days), sometimes healed by itself

Mycoplasma genitalium: cervicitis in women, nongonococcal uretritis