INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Staphylococcus aureus influenced by heavy metal ions

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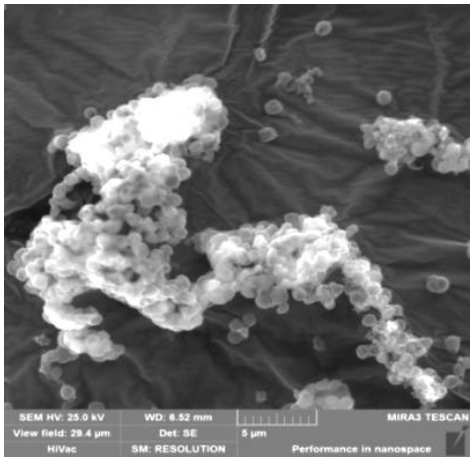
Název projektu: Partnerská síť centra excelentního bionanotechnologického výzkumu

Staphylococcus aureus

- G^+ bacterium, facultative anaerobic coccal bacterium of the genus *Staphylococcus* (Ø 1 µm),
- not always pathogenic, but often a serious agent of the bacterial infections, emerging after transplantation of implants (e.g. vascular grafts etc.)



S. aureus under electron microscopy

Colonies of *S. aureus* on Petri dish

Colonies of *S. aureus*

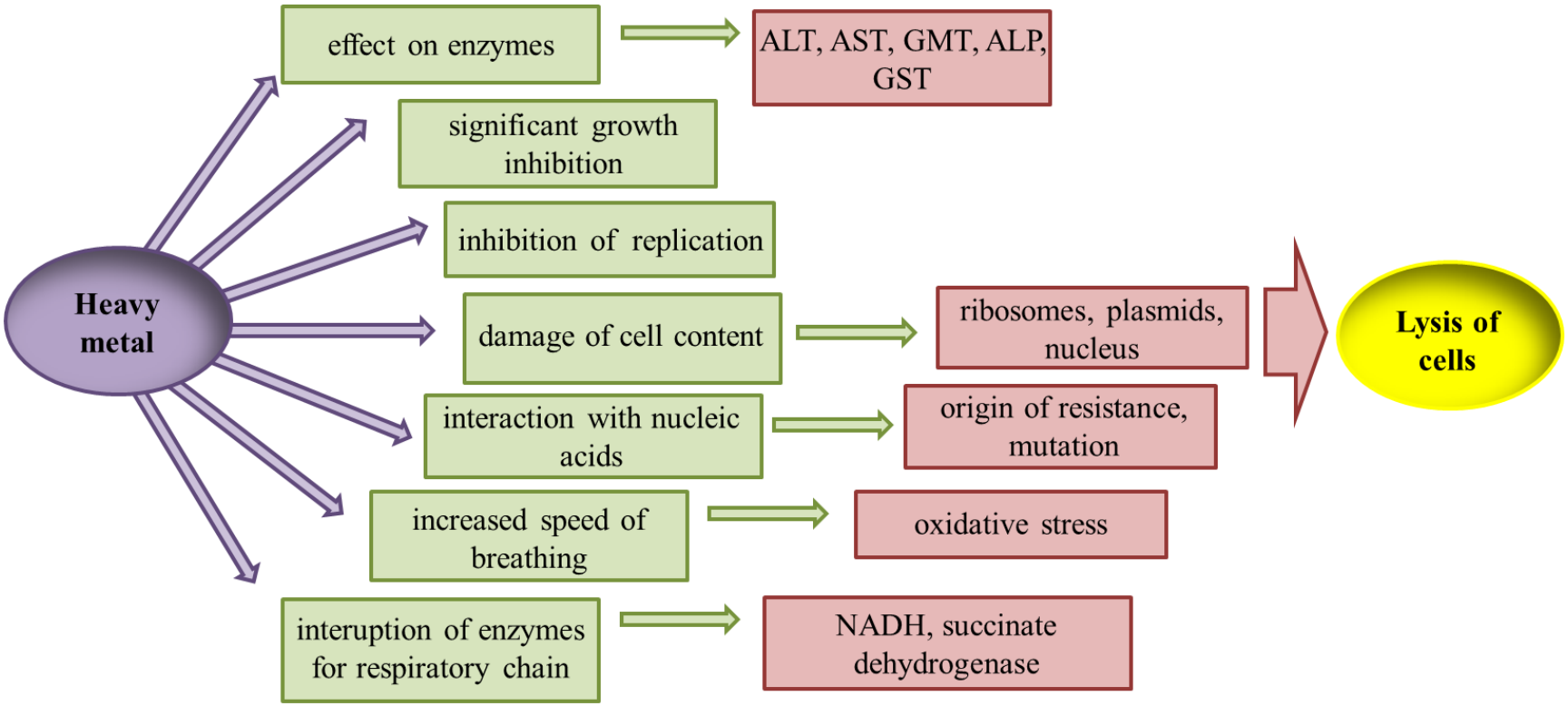
Bacterial infections: treatment and prevention

- Localized infections – surgically,
- 90 % of staphylococci are resistant to penicillin,
- macrolides, cephalosporins, aminoglycosides, tetracyclines etc.,
- prevention – vaccines to stimulate specific immunity,

Effect of heavy metal ions

- Heavy metal ions interact with cell wall, DNA, RNA and ribosomes,
- deactivate and suspend the cellular processes,
- excellent antimicrobial activity at nanomolar concentrations,

Effect of heavy metal ions



Effect of heavy metal ions

- Entry of heavy metal ions to the metabolic system → formation of components with strong oxidative potential,
- heavy metals → stress → inhibition of bacterial strains growth,
- 2 proposed principles of mechanisms

Absorption of free ions into the cell

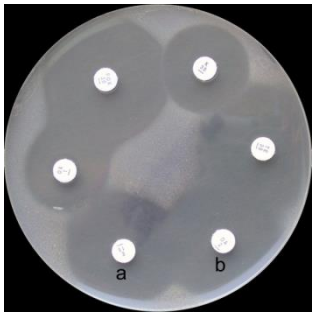
- Sorption of metal ions to the negatively charged cell wall,
- changes in molecular level → affecting of durability and function of the cell wall,
- physiological and morphological changes,
- effect of silver ions → separation of the cell wall from the cytoplasmic membrane, condensation of DNA, degradation of cell wall and a leakage of intracellular content.

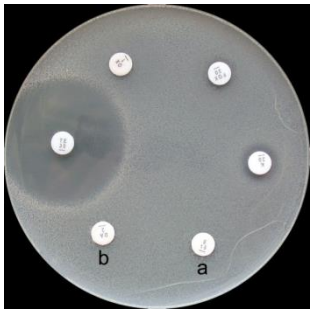
Production of reactive oxygen species

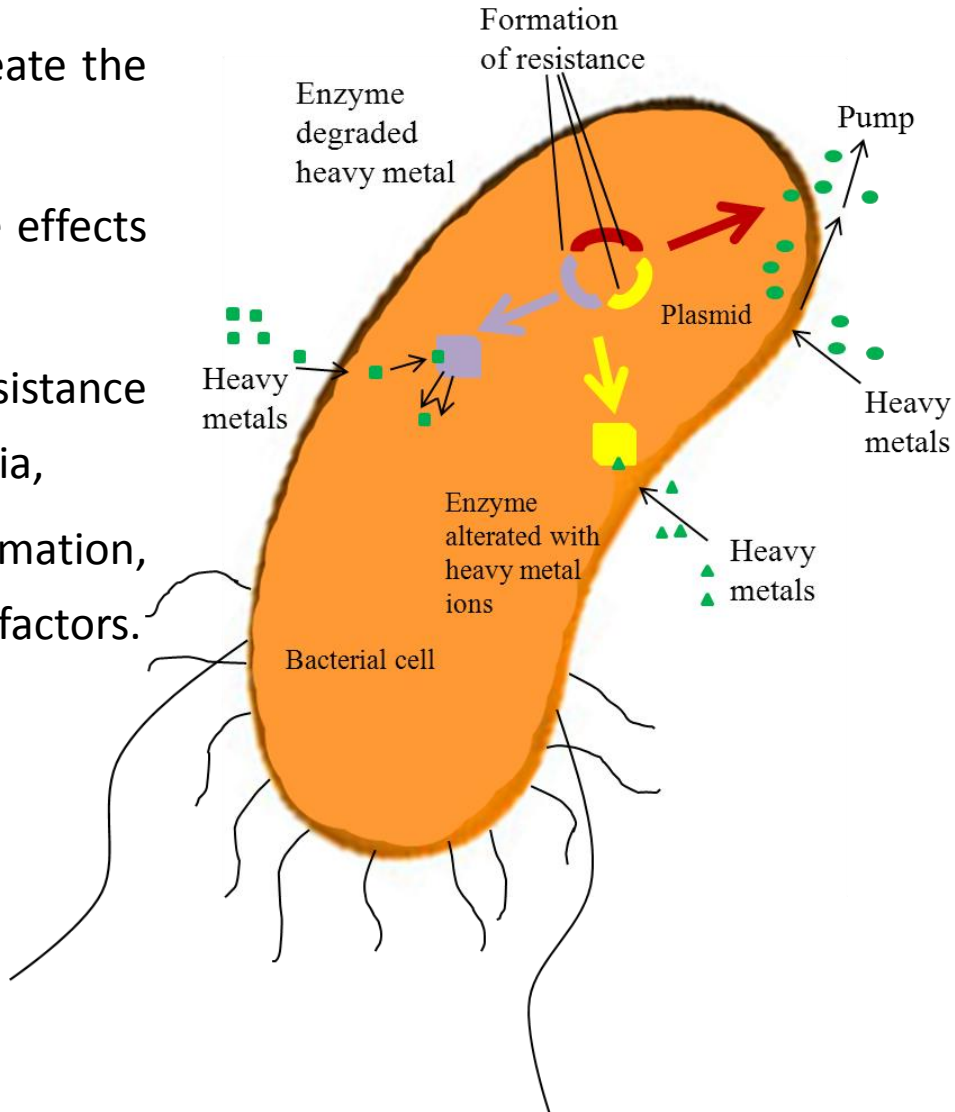
- The catalytic reaction of metal ions with oxygen,
- excessive production of ROS → formation of oxidative stress,
- free radicals attact membrane lipids → collapse of the membrane and stop of the mitochondrial function or cause the damage of DNA.

Biological resistance

- Most of bacterial strains → ability to create the resistance,
- gained by the organisms against adverse effects of internal and external environment,
- exposition to toxic metals → metal resistance comes mostly plasmid-encoded in bacteria,
- resistance genes code genetic information, which can be changed by environmental factors.

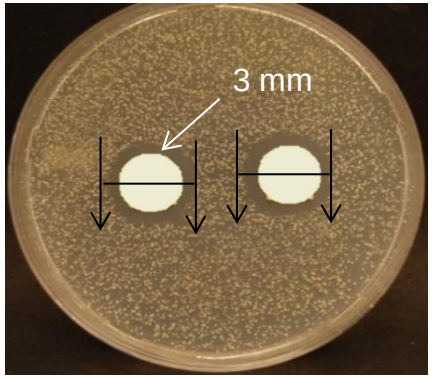




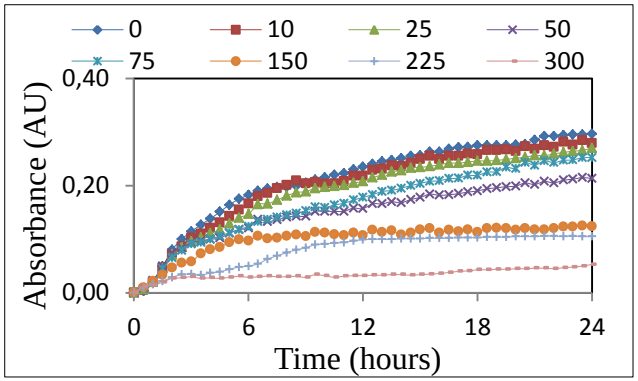


Effect of heavy metal ions in practice

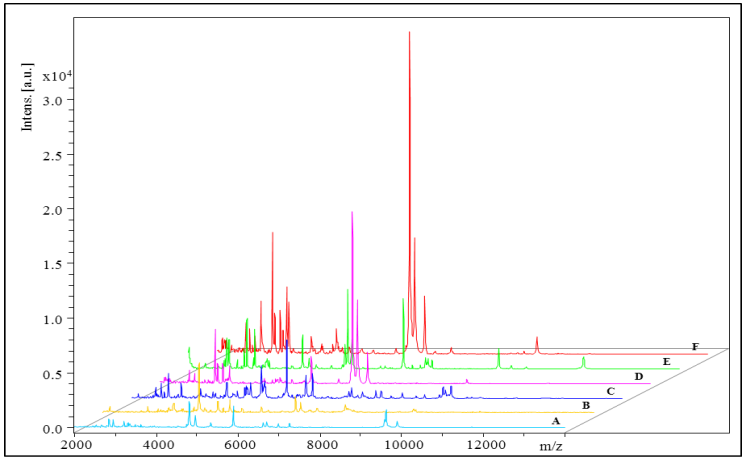
Microscopy of cells



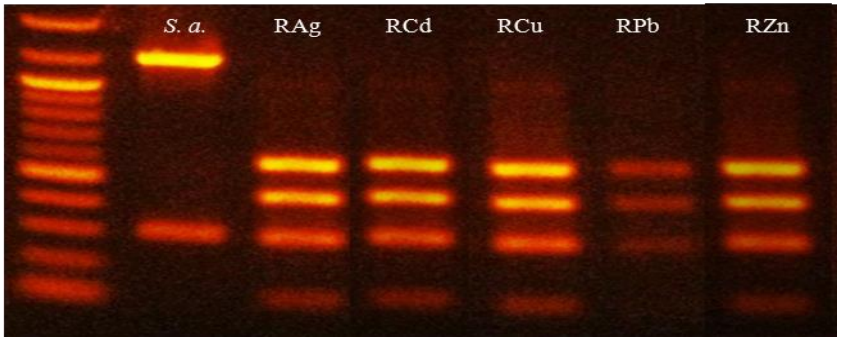
Inhibition zones



Growth curves



MALDI-TOF mass spectrometry



RFLP analysis of 16S gene

Conclusion

- Metal ions act destructively in several ways,
- the level of antibacterial effect depends on the type of bacteria,
- possible explanation – different thickness of peptidoglycan in the membrane structure of bacteria.

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Thank you for your attention

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NanoBioMetalNet