



Jean Monnet
Programme



Антибактеріальні наночастинки розробка та дослідження

«Modern European trends in biomedical higher education: Bionanomaterials.»

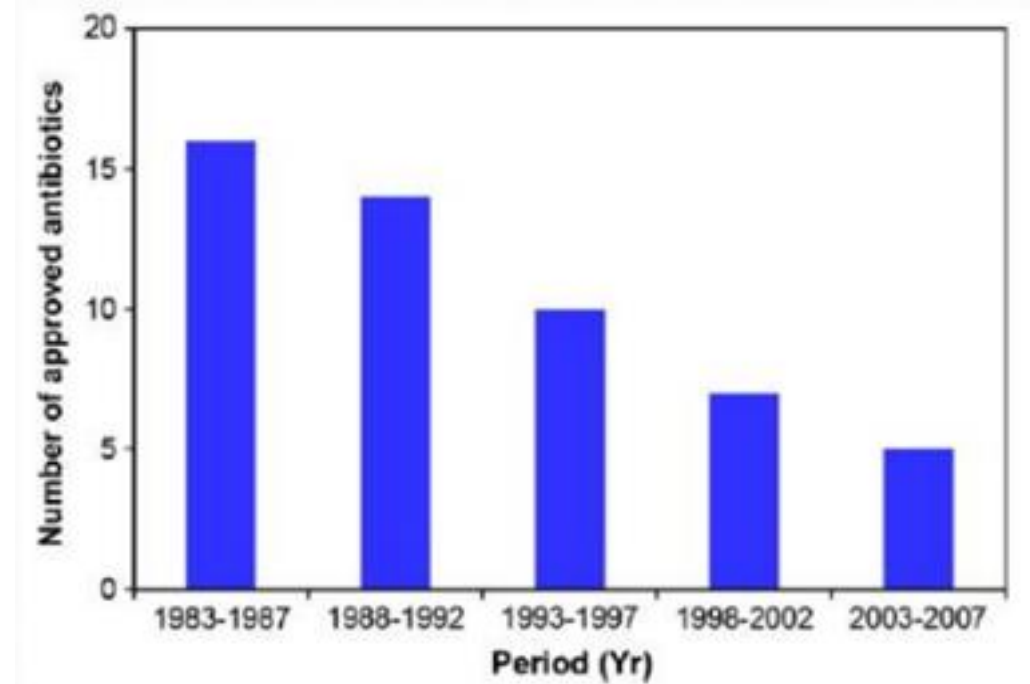
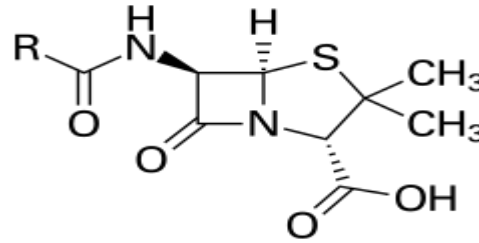
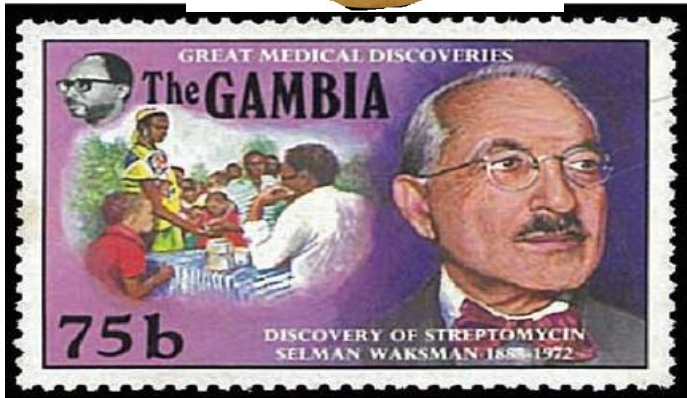
№ 620717-EPP-1-2020-1-UA-EPPJMO-MODULE



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Future of Antibiotics ?



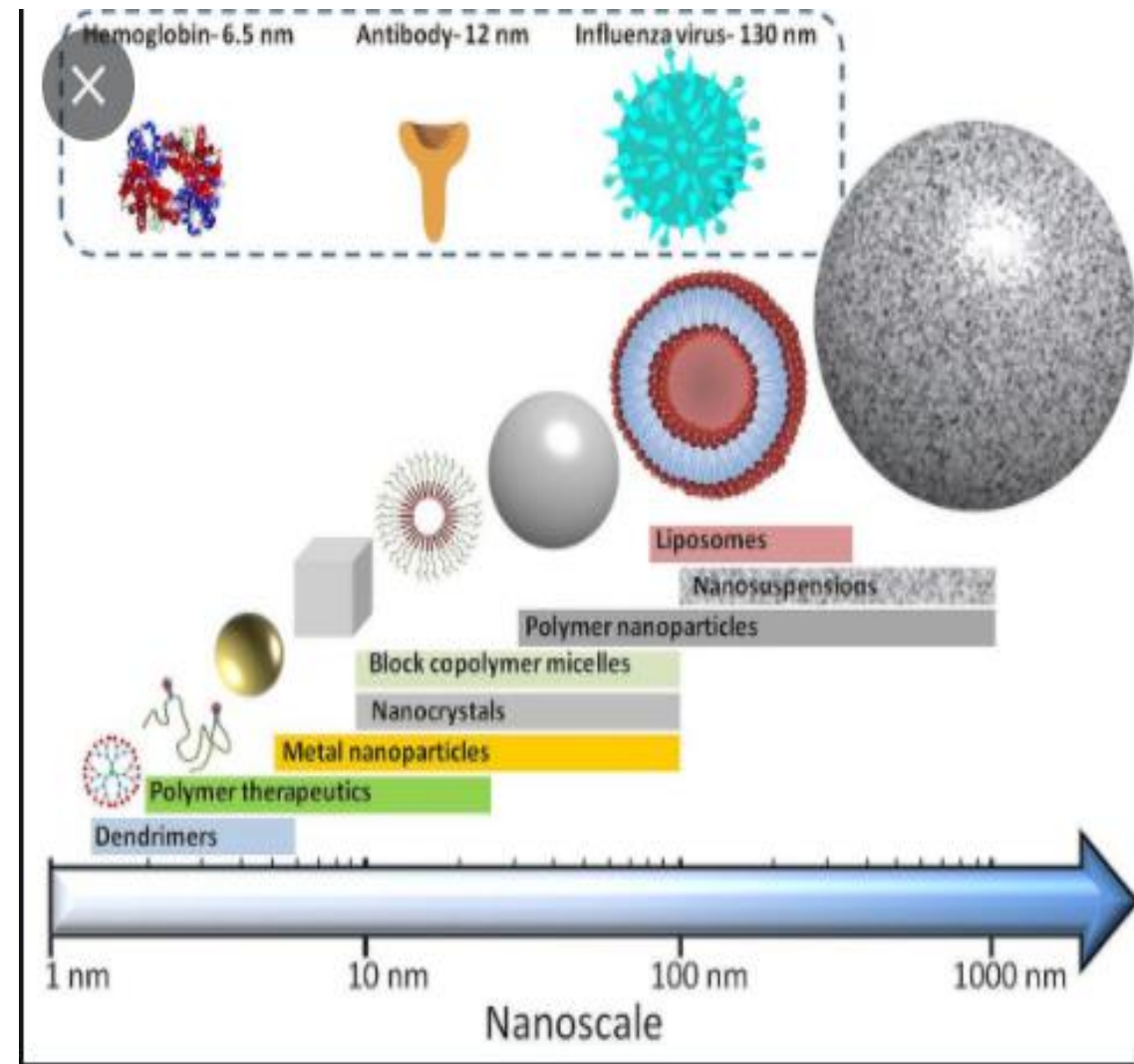
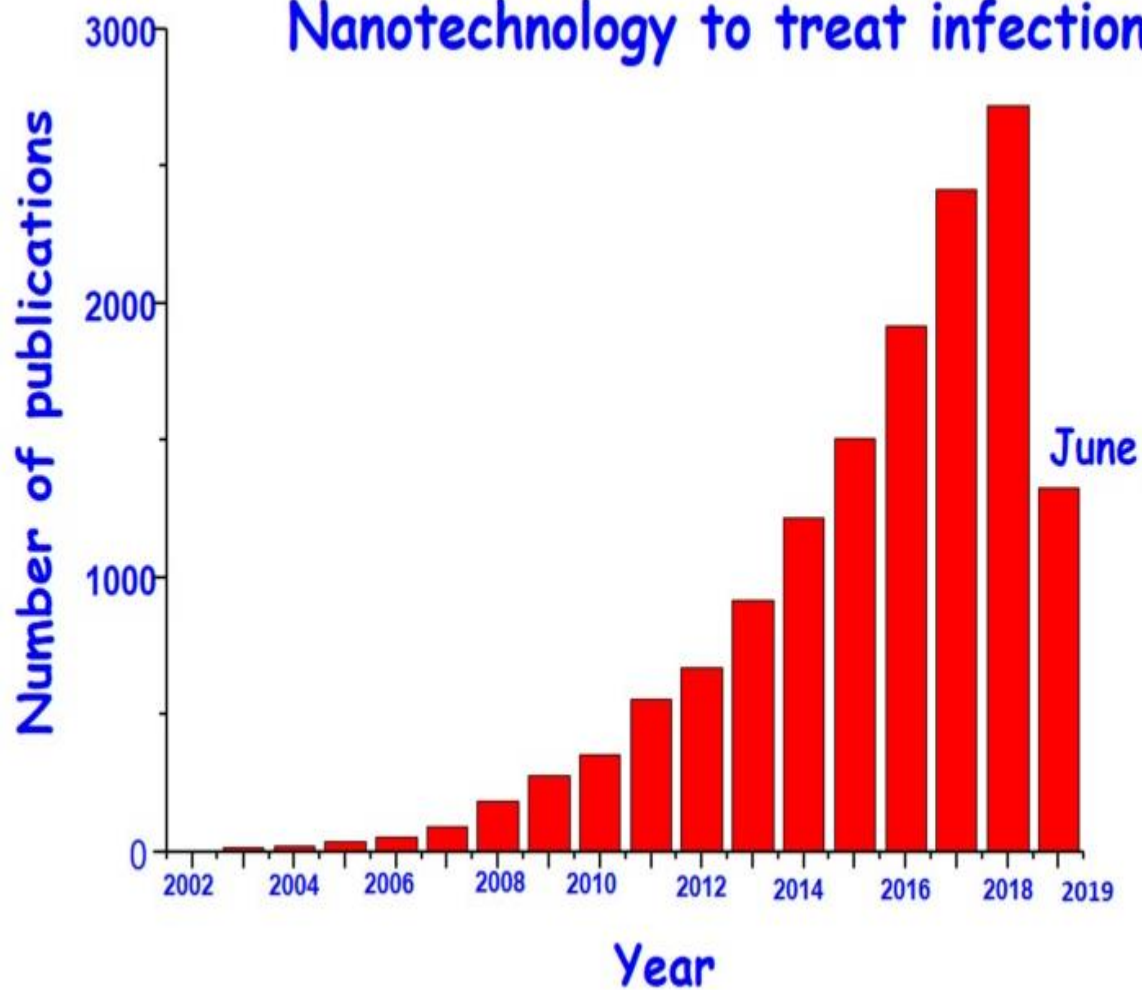
FDA approval on new antibiotics



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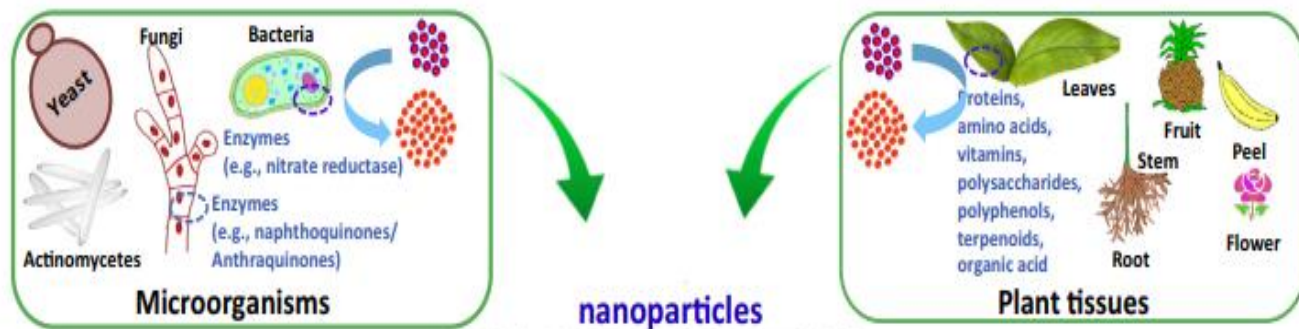
Nanotechnology to treat infection



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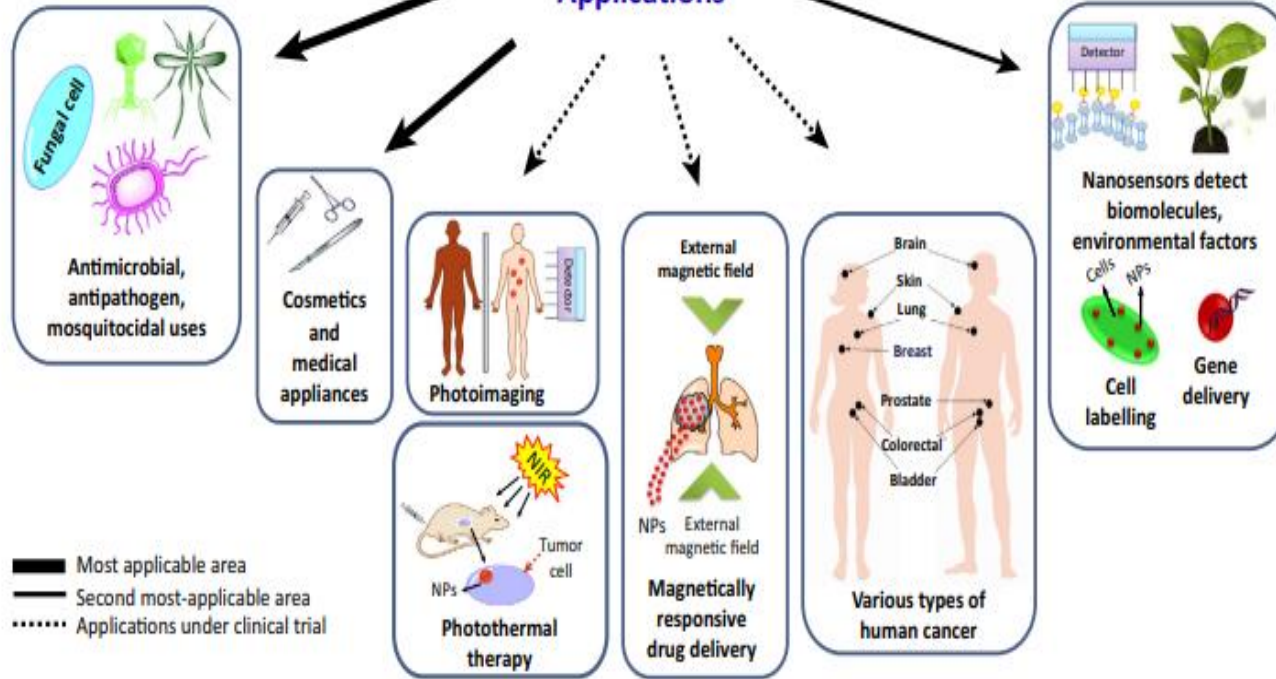


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- Metal salts
- Metal nanoparticles (NPs)

Applications



- Most applicable area
- Second most-applicable area
- Applications under clinical trial

Needs for using Nanoparticles in Antimicrobial Field

Multidrug Resistance

Side effects of antibiotics if directly used

For drug delivery

For long term storage



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Nanoparticles

Inorganic Nanoparticles

Examples:

Metals and Metal oxides like

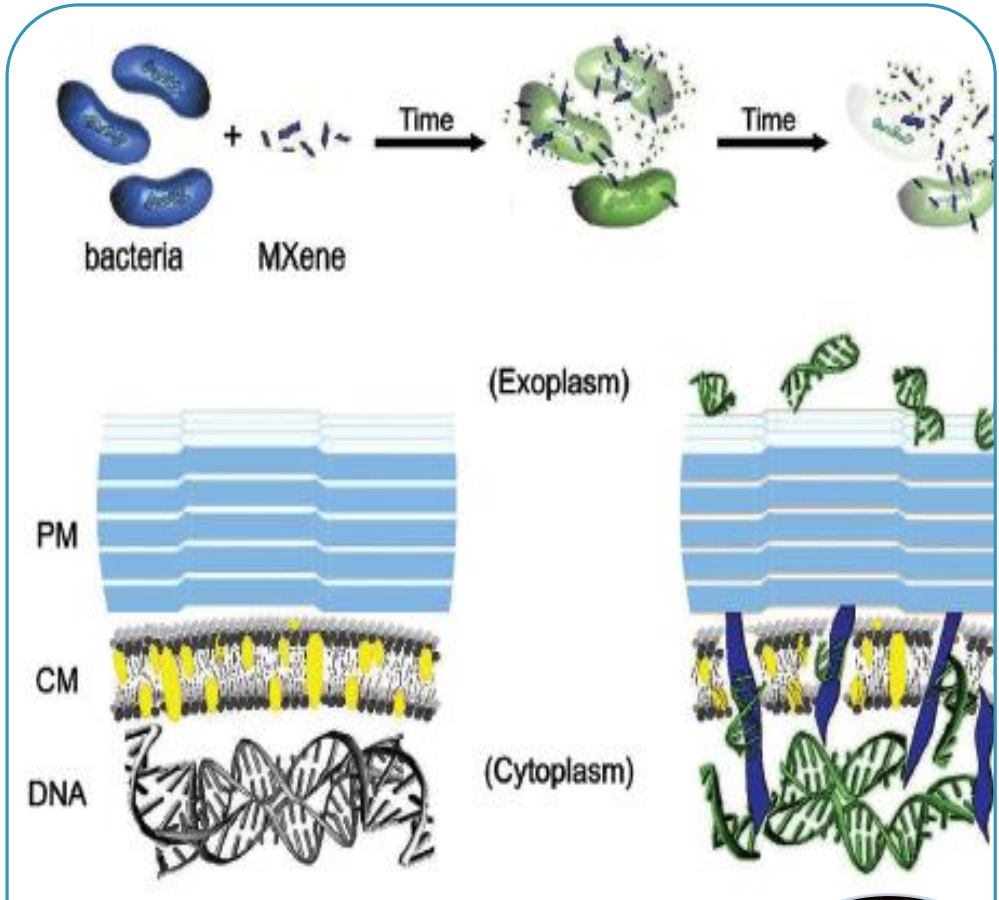
- Silver (Ag)
- Iron oxide (Fe_3O_4)
- Titanium oxide (TiO_2)
- Copper oxide (CuO)
- Zinc oxide (ZnO)

Organic Nanoparticles

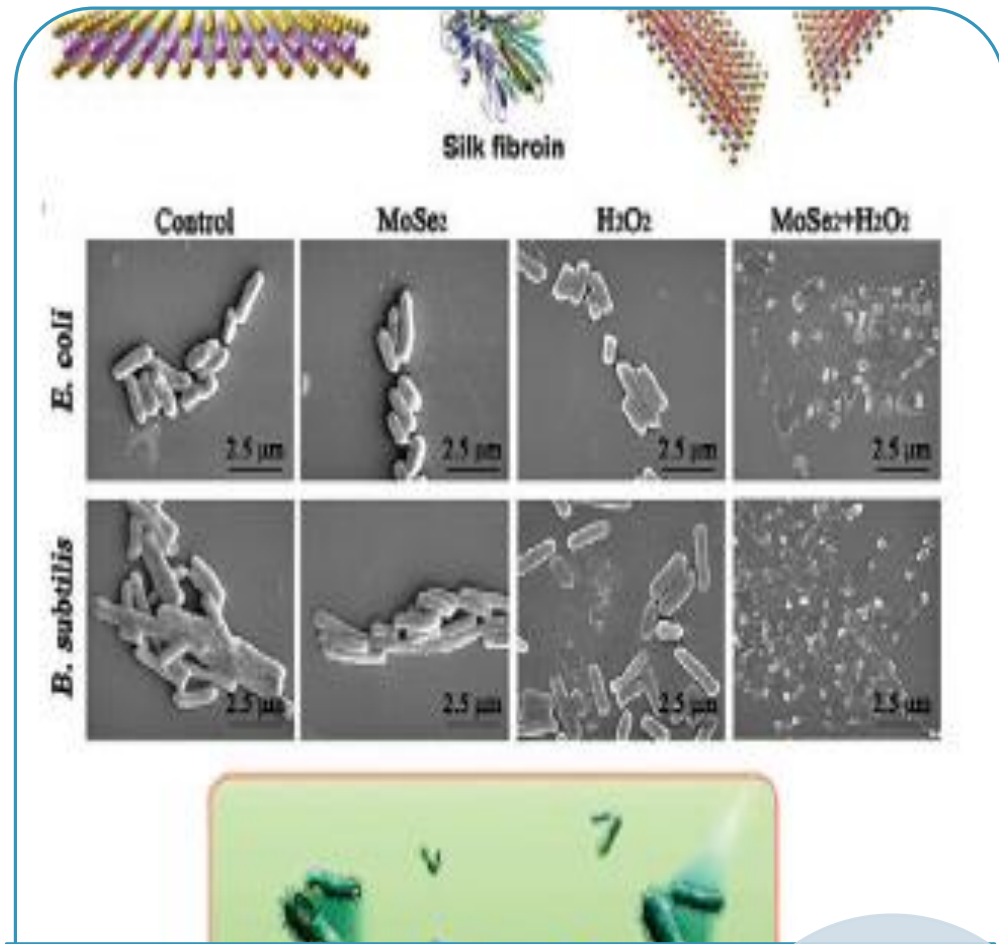
Examples :

- Poly - ϵ -lysine
- Quaternary ammonium compounds
- Cationic quaternary polyelectrolytes
- N- halamine compounds
- chitosan etc





MXenes



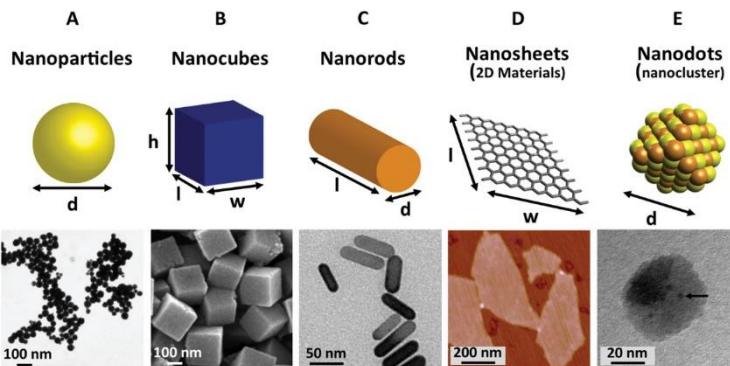
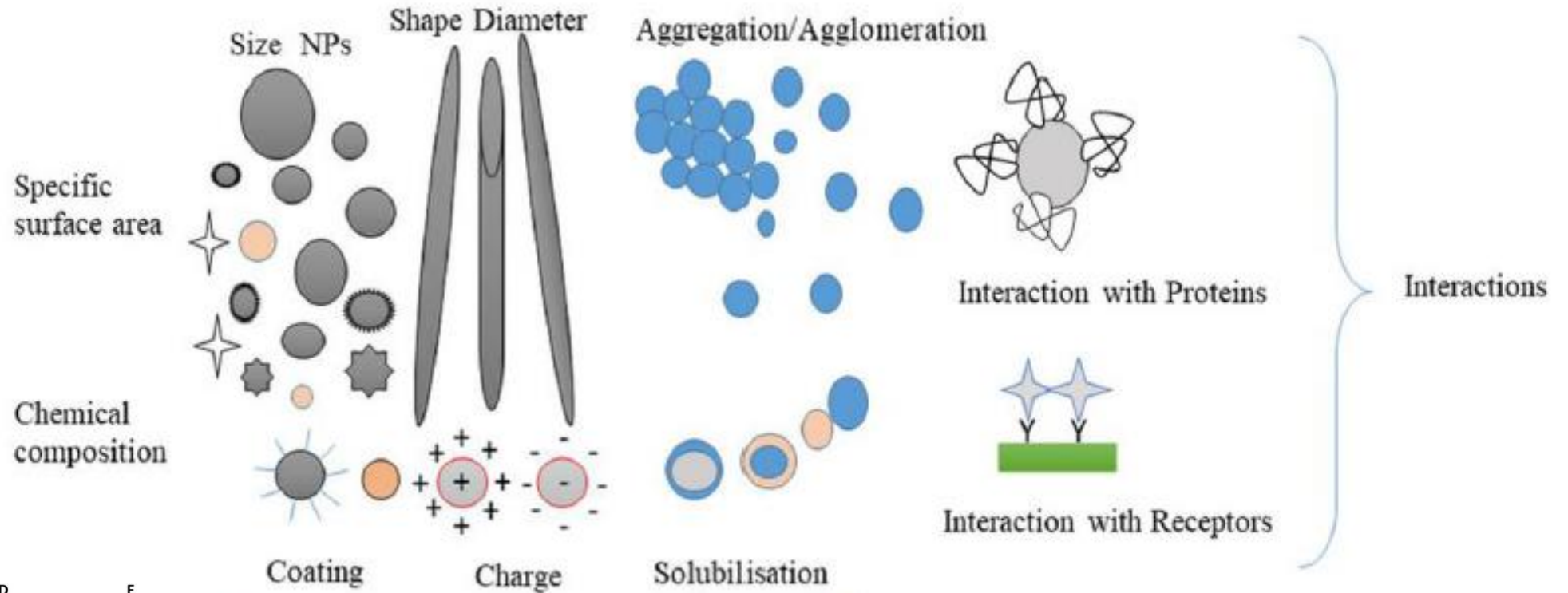
Transition Metal Dichalcogenides



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Physicochemical properties of the NPs involved in biological activity



Surface chemistry



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Antimicrobial NPs :

➤ Advantage:

- Targeted drug delivery via specific accumulation
- Lowered side effects of chemical antimicrobials
- Extended therapeutic lifetime due to slow elimination
- Controlled drug release
- Broad therapeutic index
- Low cost

➤ Disadvantage:

- High systemic exposure to locally administrated drugs
- Nanotoxicity (lung, kidney, liver, brain, germ cell, metabolic, etc.)
- Lack of characterization techniques.



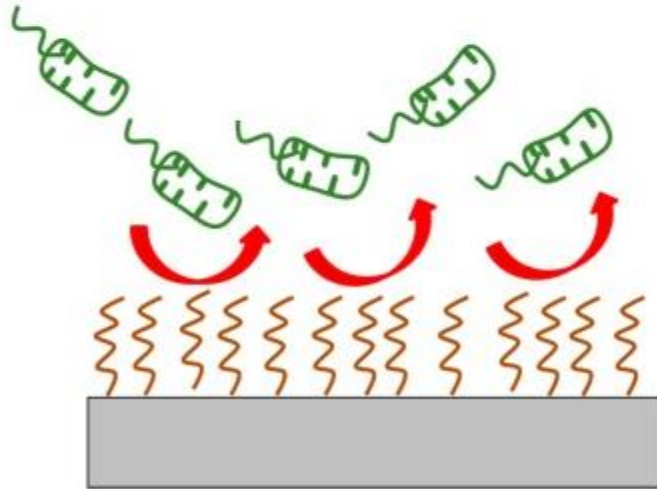
The challenge

Preventing infection

Inhibiting bacterial adhesion and biofilm formation



Non-fouling surfaces



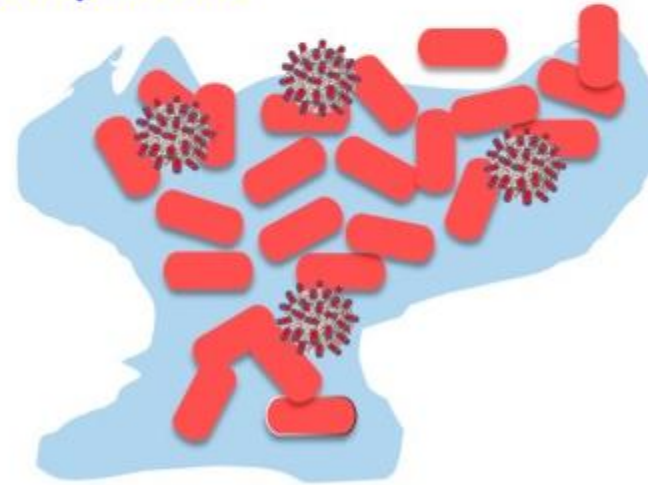
Combating infection

Destroying the biofilm and killing bacteria



Antimicrobial Nanoparticles

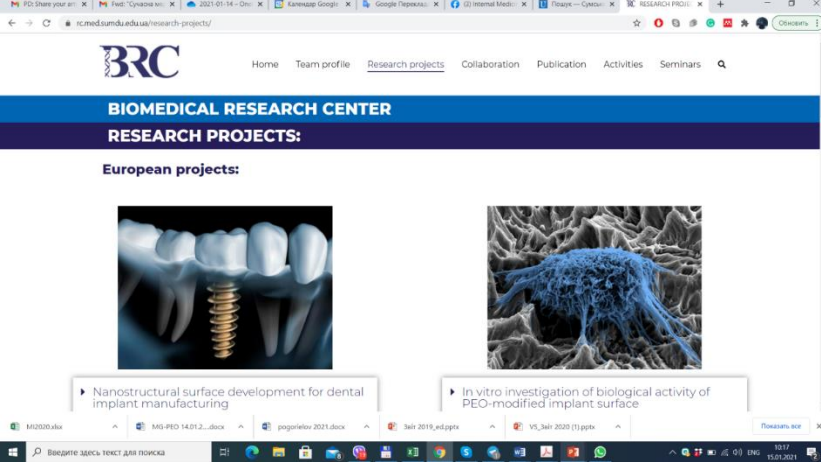
Nanocarriers



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Preventing the Bacterial Adhesion

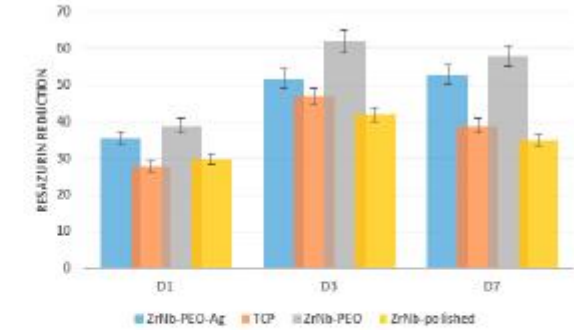
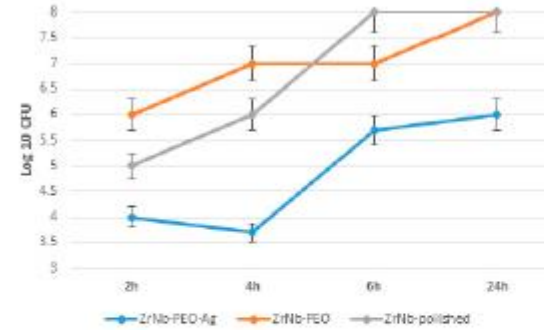
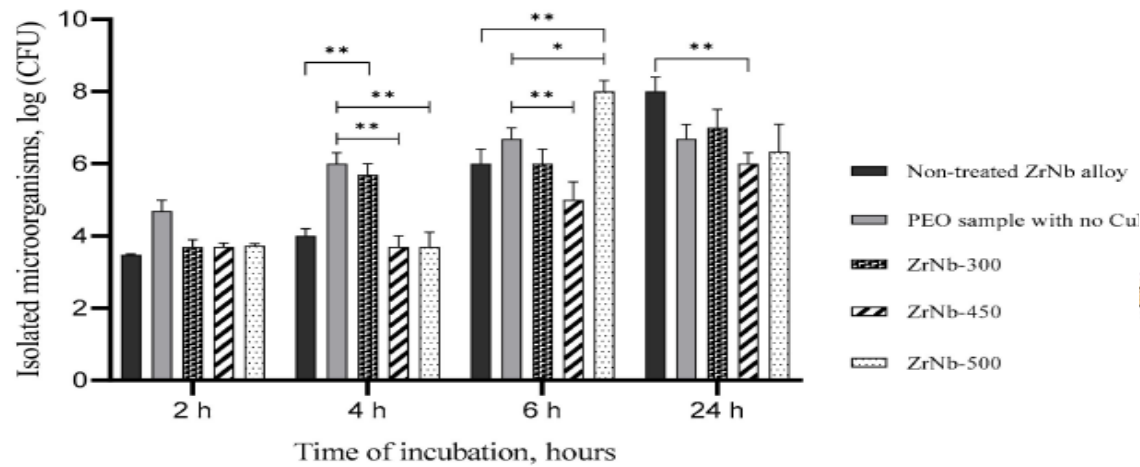


Figure 6. Bacterial adhesion over 24 h (a) and osteoblast adhesion and 7-day proliferation (b) on the



Article

Ag Nanoparticle-Decorated Oxide Coatings Formed via Plasma Electrolytic Oxidation on ZrNb Alloy

Oleksandr Oleshko ¹, Volodymyr Deineka V ¹, Yevgeniia Husak ¹, Viktoriia Korniienko ¹, Oleg Mishchenko ², Viktoriia Holubnycha ¹, Marcin Pisarek ³, Joanna Michalska ⁴, Alicja Kazek-Kęsik ⁴, Agata Jakóbiak-Kolon ⁴, Wojciech Simka ^{2,4,*} and Maksym Pogorielov ^{1,2,*}



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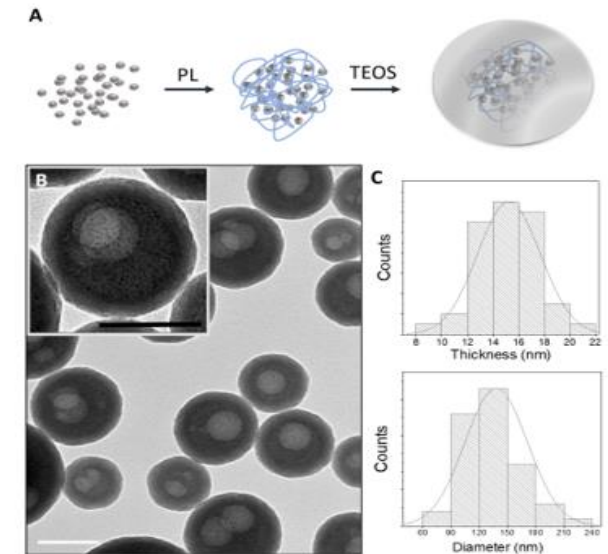
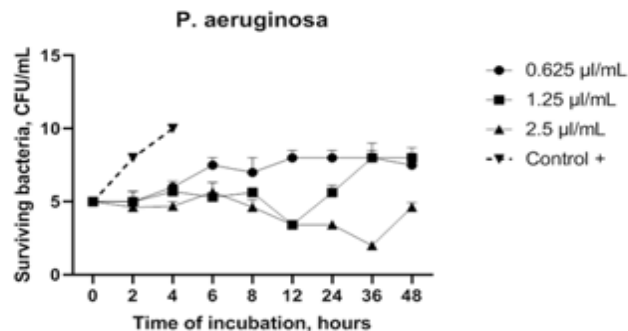
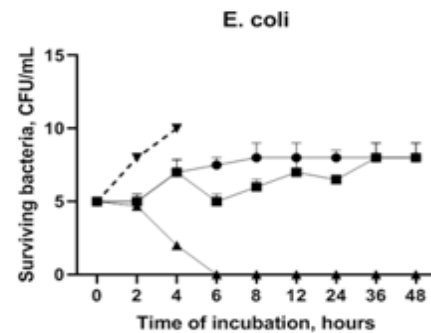
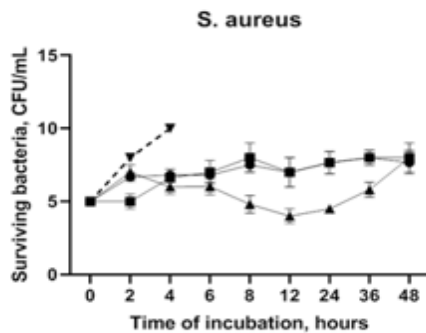
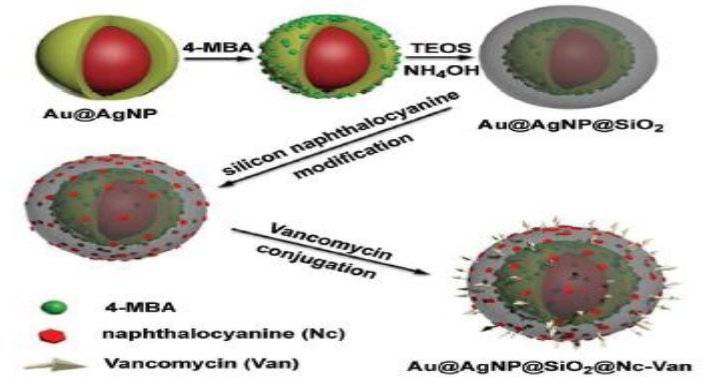
Article

Formation of a Bacteriostatic Surface on ZrNb Alloy via Anodization in a Solution Containing Cu Nanoparticles

Viktoriia Korniienko ¹, Oleksandr Oleshko ¹, Yevheniia Husak ¹, Volodymyr Deineka ¹, Viktoriia Holubnycha ¹, Oleg Mishchenko ², Alicja Kazek-Kęsik ³, Agata Jakóbiak-Kolon ³, Roman Pshenychnyi ¹, Katarzyna Leśniak-Ziółkowska ³, Oksana Kalinkevich ⁴, Aleksei Kalinkevich ⁴, Marcin Pisarek ⁵, Wojciech Simka ^{2,3,*} and Maksym Pogorielov ^{1,2,*}

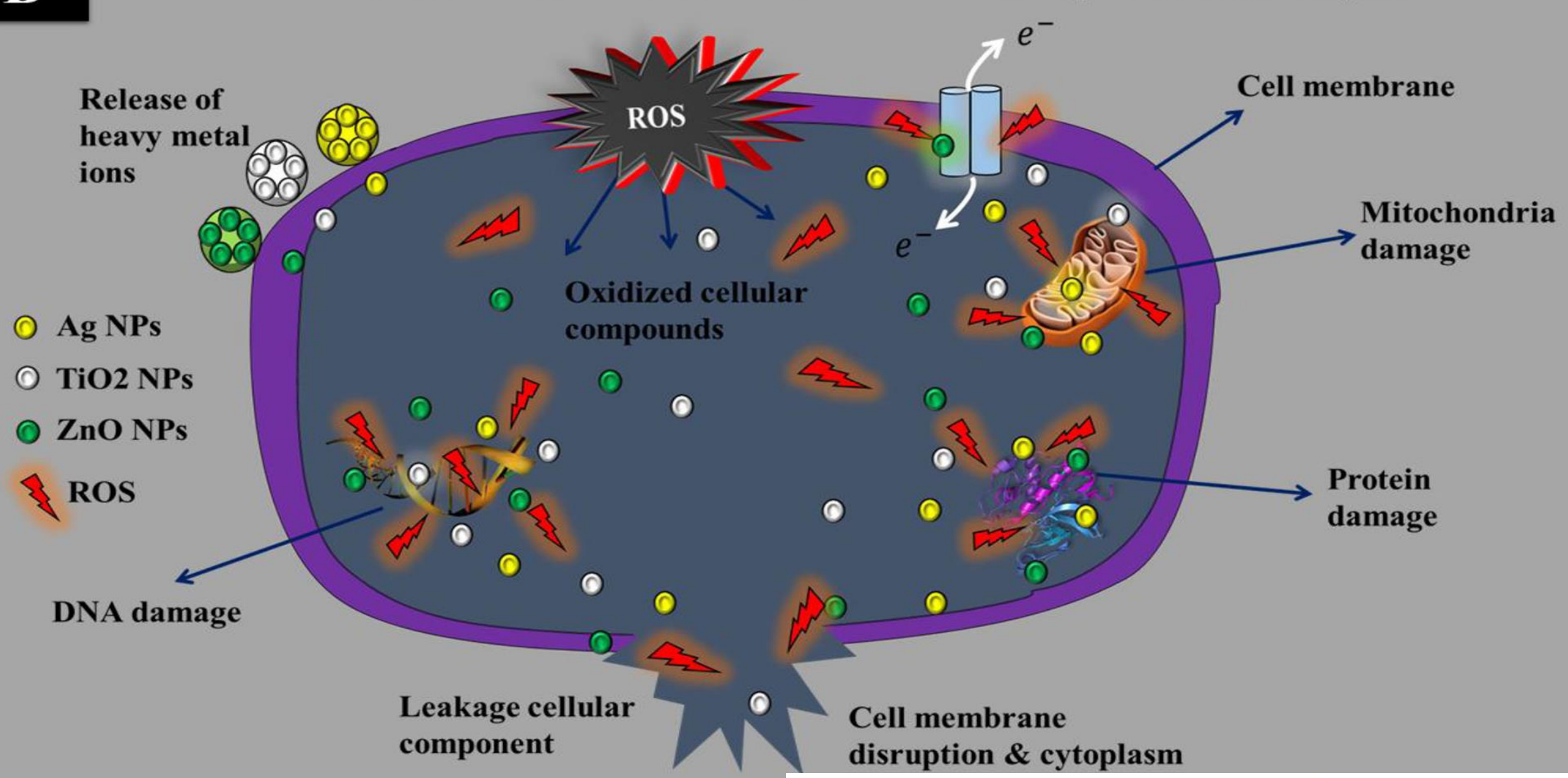
Nanomaterials with Unique Features as Potential Weapons to Fight Infections

1. Nanoparticles with Inherent Antibacterial Properties
2. Nanomaterials as Nanocarriers: Mesoporous Silica Nanoparticles



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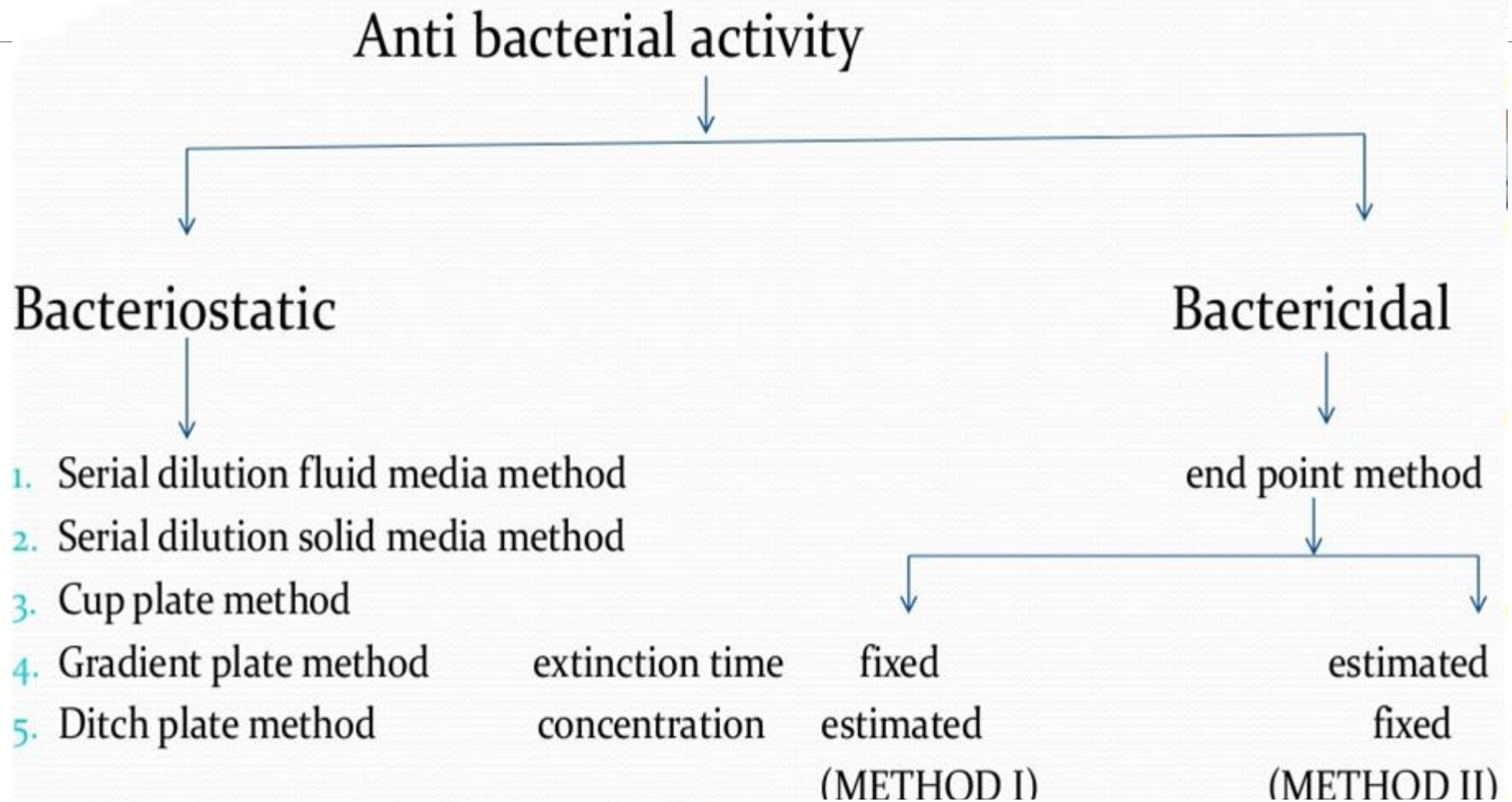


B**Reactive Oxygen Species generation****Interrupted electron transport**

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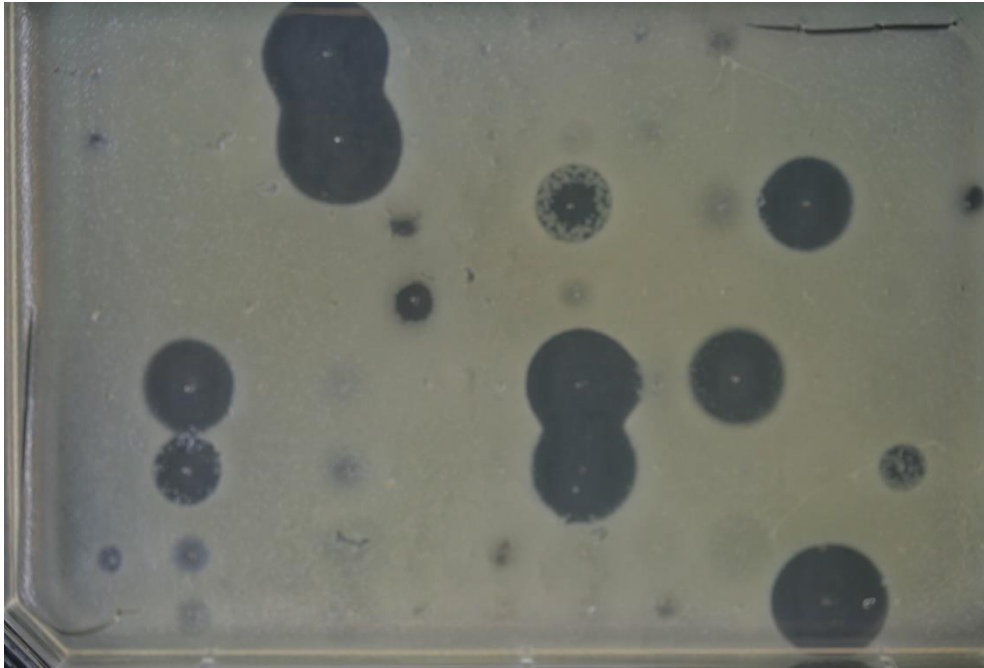


In vitro antibacterial activity screening

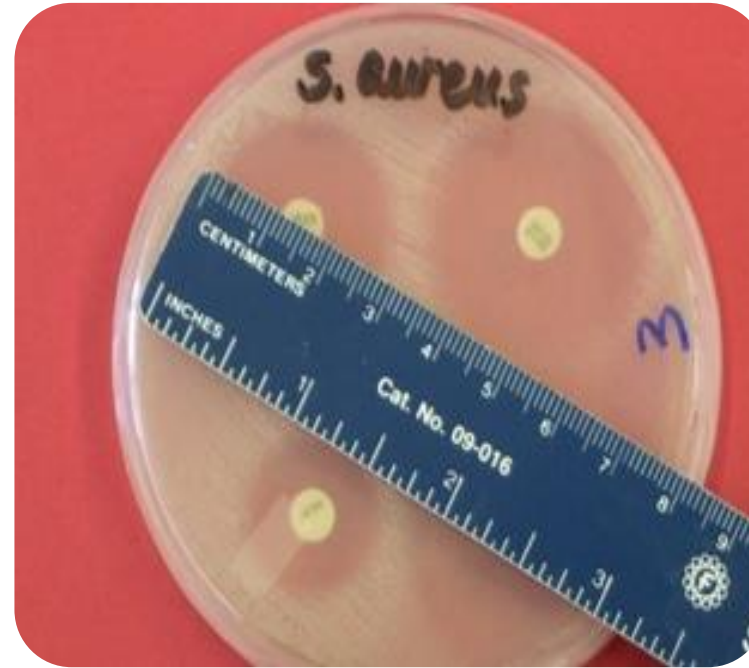


Qualitative methods

LAWN ASSAY



DISC DIFFUSION METHOD



CUP DIFFUSION METHOD



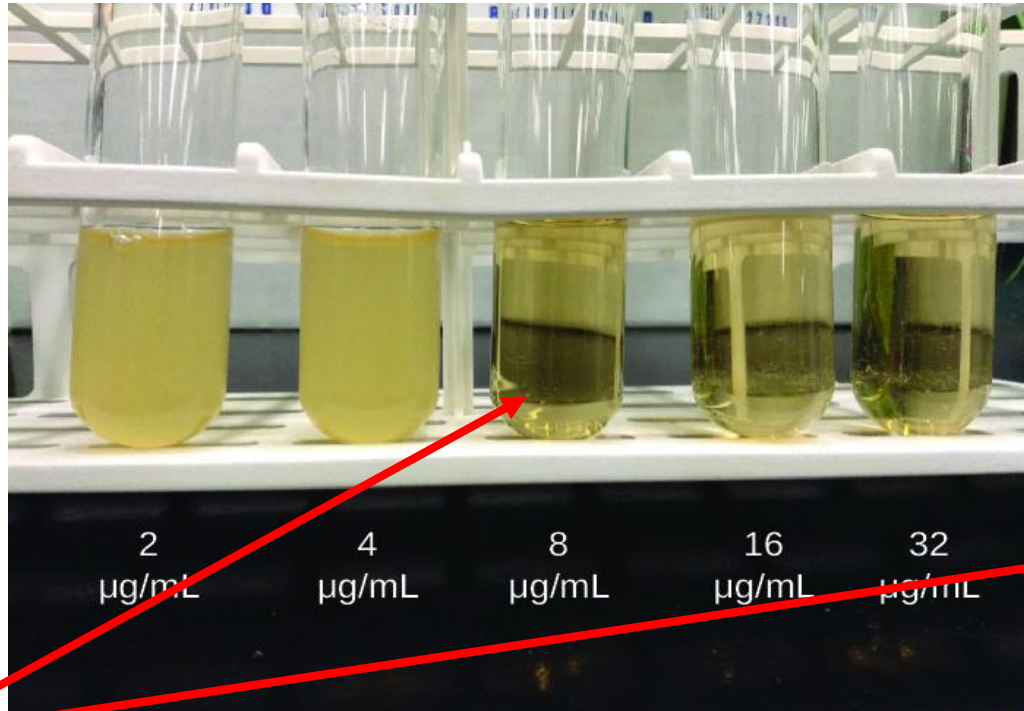
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Quantitative methods

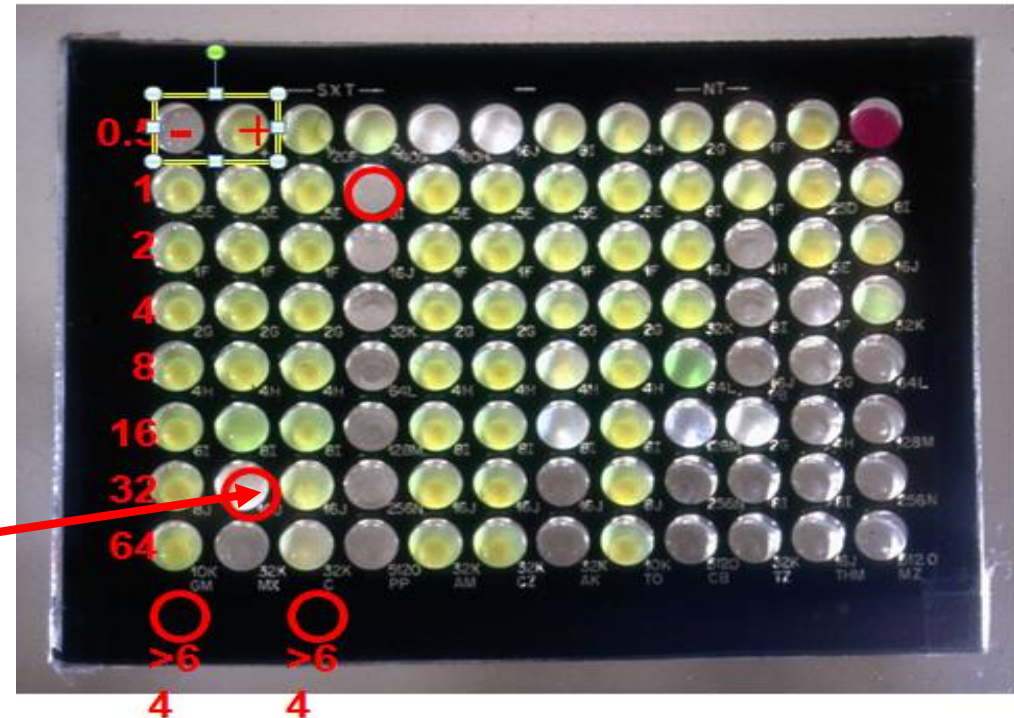
MACRO DILUTION (TUBE)



MIC

MICRODILUTION

96 well microtiter plate

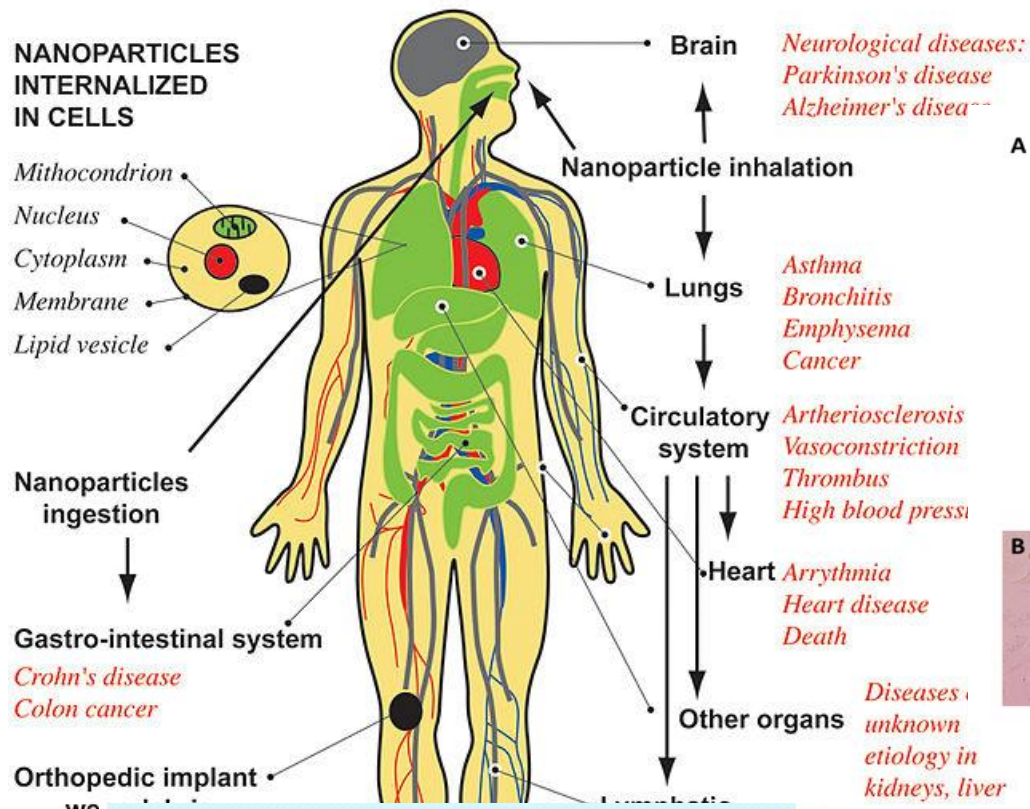


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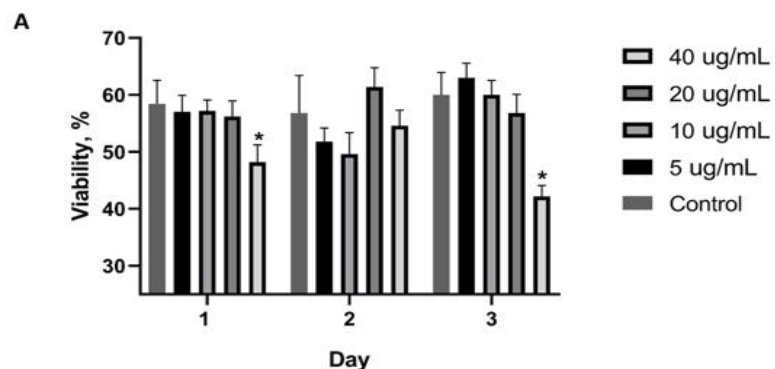
DISEASES ASSOCIATED TO NANOPARTICLE EXPOSURE

C. Buzea, I. Pacheco, & K. Robbie, *Nanomaterials and nanoparticles: Sources and toxicity, Biointerphases 2 (2007) MR17-MR71*



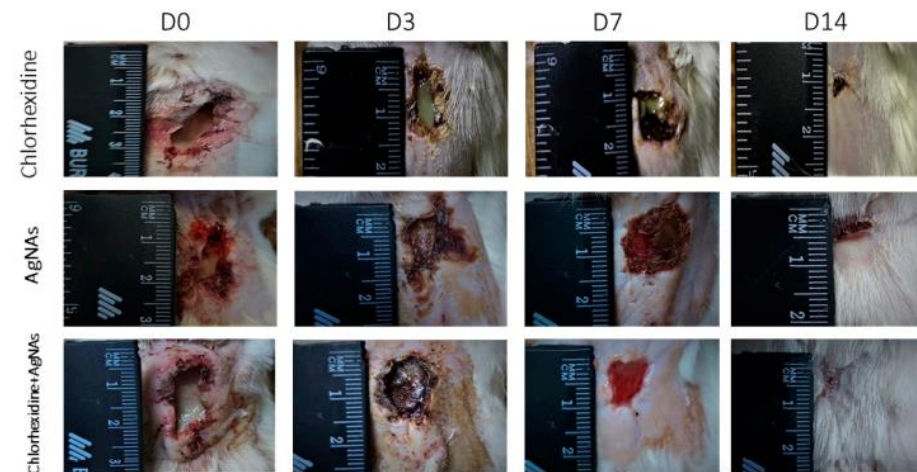
Assessment of NPs toxicity

Cell cultures (in vitro)



On animals' model (in vivo)

WOUND MORPHOLOGY



Argyria

Argyria, Pseudoconiosis, Kaposi's sarcoma, Immune diseases, Dermatitis



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Silver NPs

- 1) Bone cement
- 2) Implantable devices
- 3) Additive in polymerizable dental materials
- 4) Toothpastes
- 5) Surgical gowns
- 6) Face masks
- 7) Wound dressing and burn treatments
- 8) Coating plastic catheters
- 9) Coating of endotracheal tube
- 10) Disinfecting medical devices

Medical and dental applications



Disinfectants



Nasal spray



Toothpaste



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Other applications

- 1) Food storage packaging
- 2) Textile coatings, socks and athletic clothing
- 3) Packaging
- 4) Cosmetics
- 5) Water treatment
- 6) Washing machines
- 7) Detergents, soaps and shampoos
- 8) Air and water filters



Socks



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Thank you very much
for your attention!!!



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<https://www.youtube.com/watch?v=r1beoT9e38I>

[https://www.youtube.com/watch?v=aYxpA0GL8Ss&list=TLPQM
TkwNDIwMjE_MuIXMpTR8Q&index=4](https://www.youtube.com/watch?v=aYxpA0GL8Ss&list=TLPQM
TkwNDIwMjE_MuIXMpTR8Q&index=4)

<https://www.youtube.com/watch?v=NYDOZzpH99E>



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