Short Bio:

Dr. Chatzistavrou is appointed as an assistant professor in the department of Chemical Engineering at the Aristotle University of Thessaloniki, Greece and she is also an adjunct professor in the department of Chemical Engineering and Materials Science at Michigan State University, USA. Her research interests focus on the development of novel bioactive and antibacterial materials for tissue healing and regeneration. Her group has developed novel bioactive glasses and glass ceramics with bactericidal action against antibiotic-resistant strains and tissue regenerative characteristics. She has two patent applications, more than 60 papers in peer review journals, book chapters, and invited talks at national and international conferences. She has been also an editor in the Materials Letters journal. Finally, she was the recipient of the prestigious Marie Curie and JSPS fellowships.

Abstract:

This talk aims to present the characteristics of multi-component particles in the system SiO_2 58.6-CaO 24.9-P_2O_5 7.2-Al_2O_3 4.2-Na_2O 1.5-K_2O 1.5-Ag_2O 2.1 wt% (Ag-BG) and the impact to bioactive and antibacterial properties by moving from micro- to nano- scale. The need for developing and applying tailored synthesis protocols is discussed to deliver nanoparticles in the specific system. The changes in the characteristics of the nano-size particles are presented. Finally, the advancements in their antibacterial and biological properties are discussed.

Bioactive and Antibacterial Multi-Component Particles: The Impact of Moving from Micro to Nano Scale

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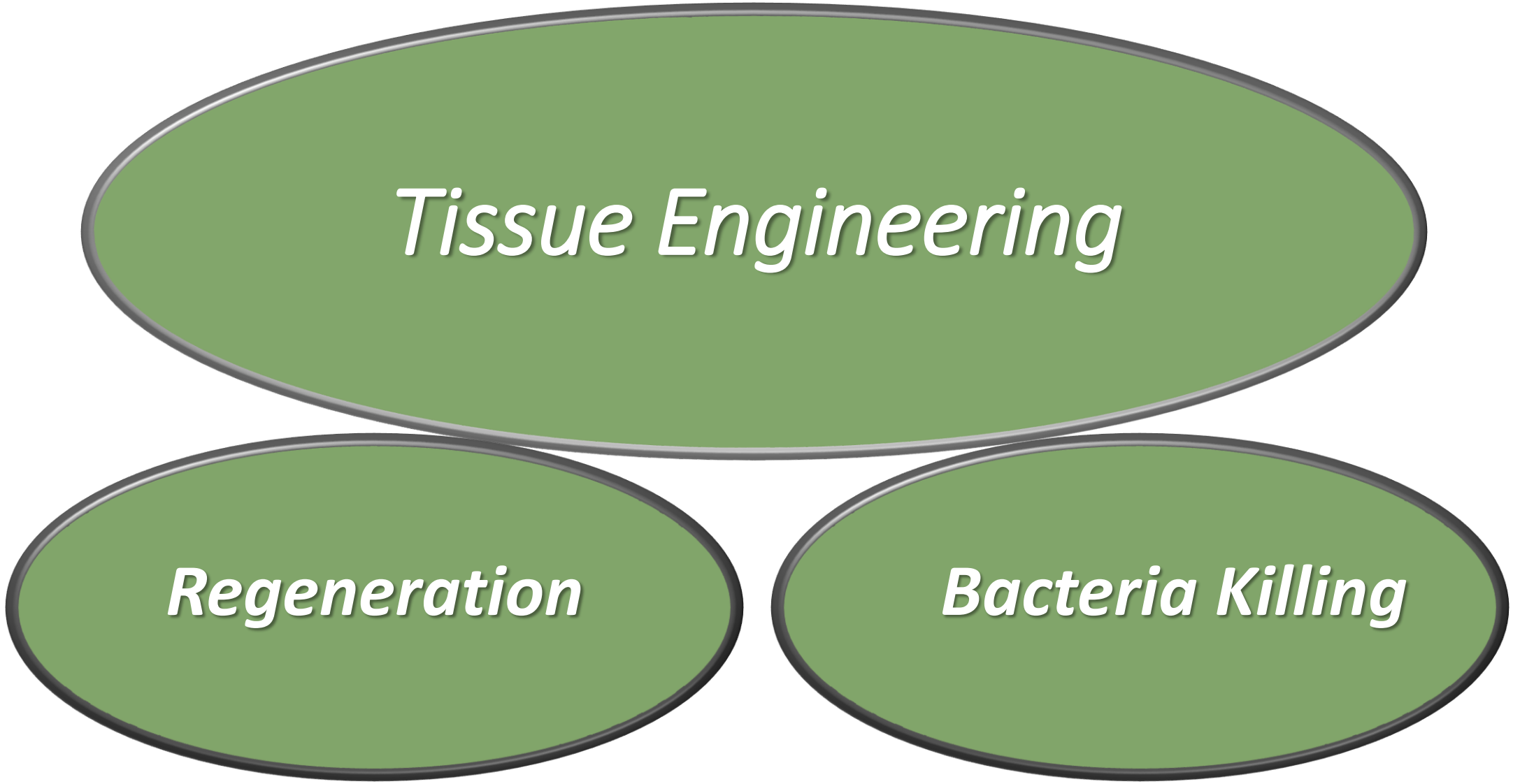
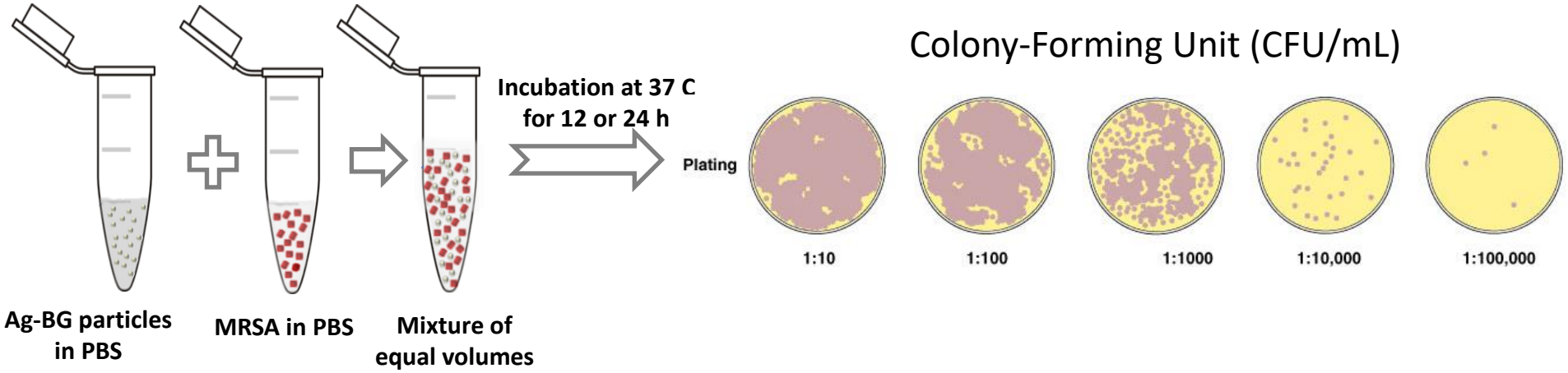
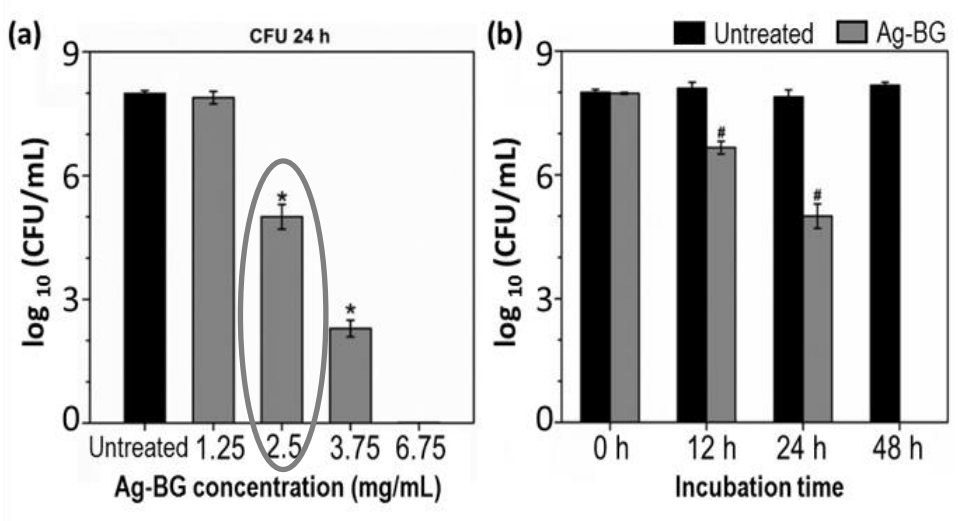
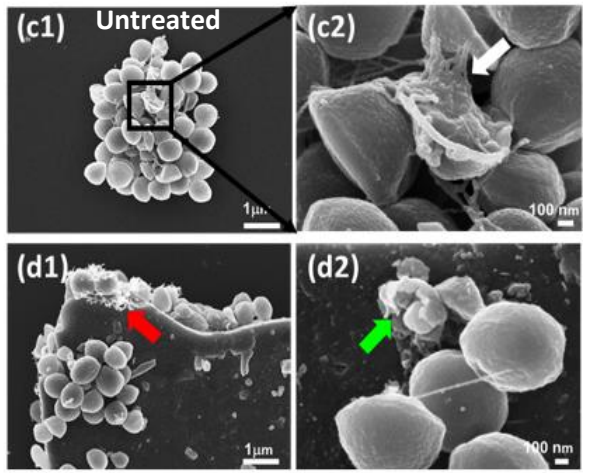

Tissue Engineering
Regeneration
Bacteria Killing

➢ Antibacterial Activity against Methicillin-Resistant *Staphylococcus aureus* (MRSA)

MRSA Exposed to Ag-BG



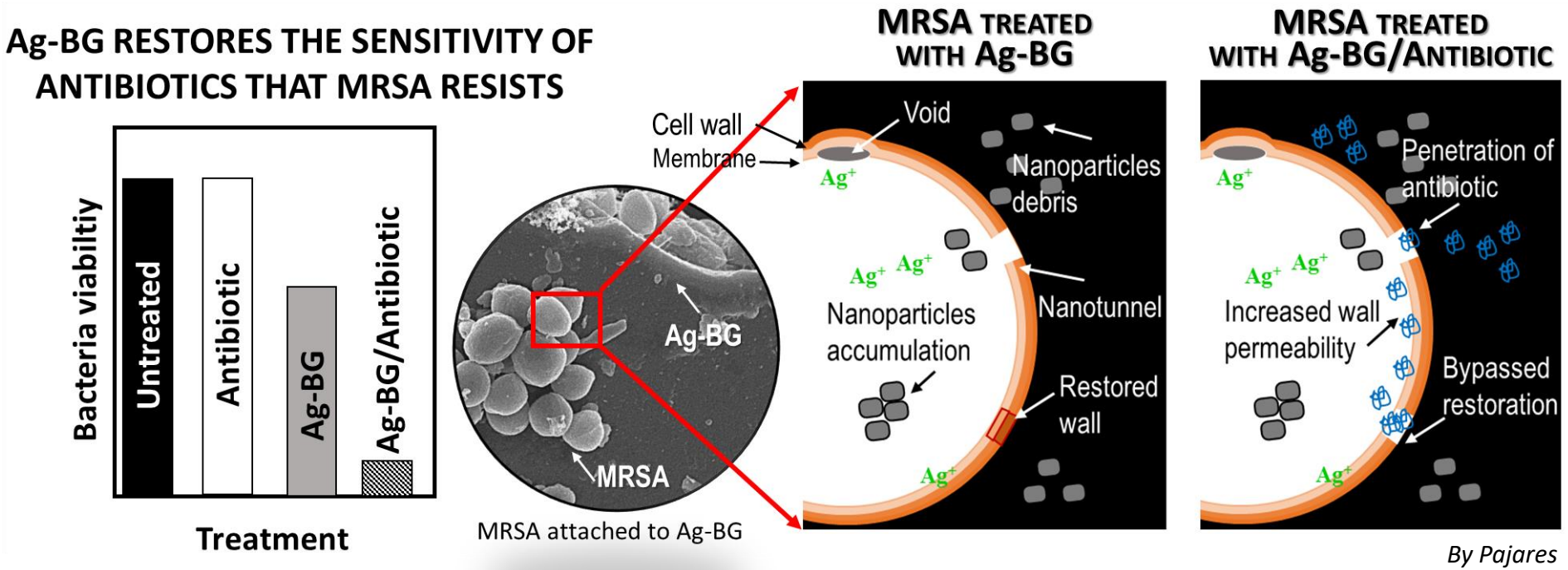




- Released Cytoplasm
- Cell-wall Fragments

Pajares et. al. Resurrection of Antibiotics that MRSA Resists by Silver-Doped Bioactive Glass-Ceramic Microparticles. Acta Biomaterialia 96, 537-546

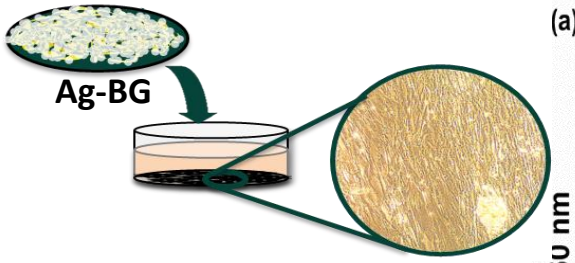
➢ MECHANISMS OF ANTIMICROBIAL ACTIVITY



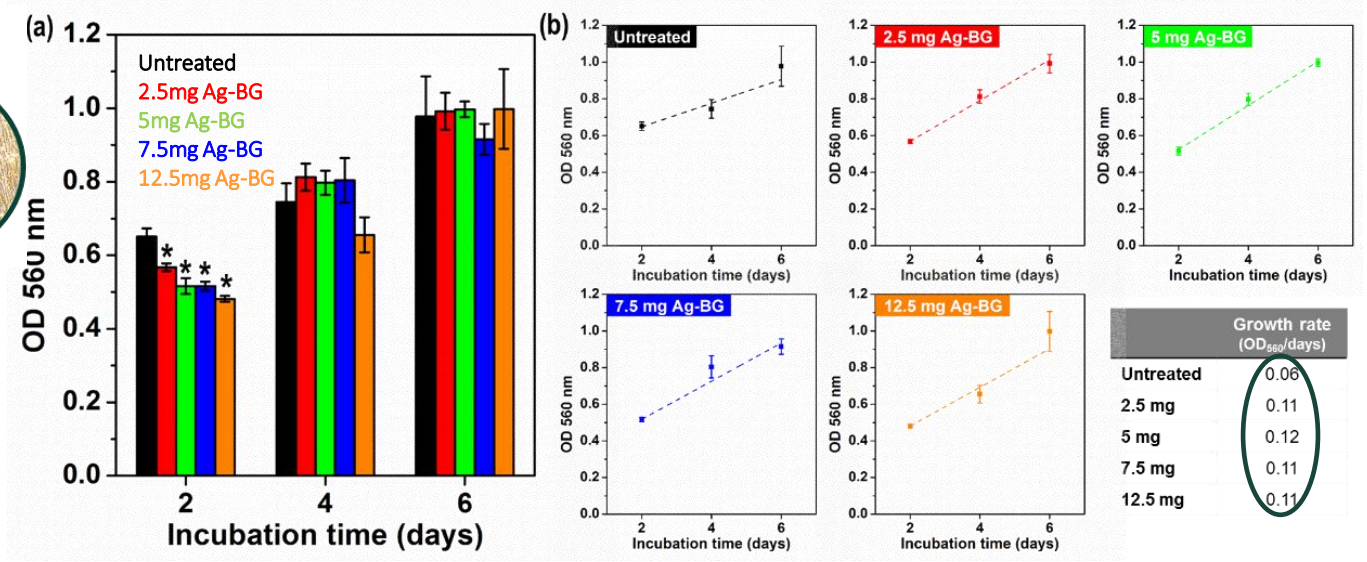
- Released ions and nanosized debris from Ag-BG particles damage cell wall.
- Antibiotics bypass cell resistance when delivered with Ag-BG particles.

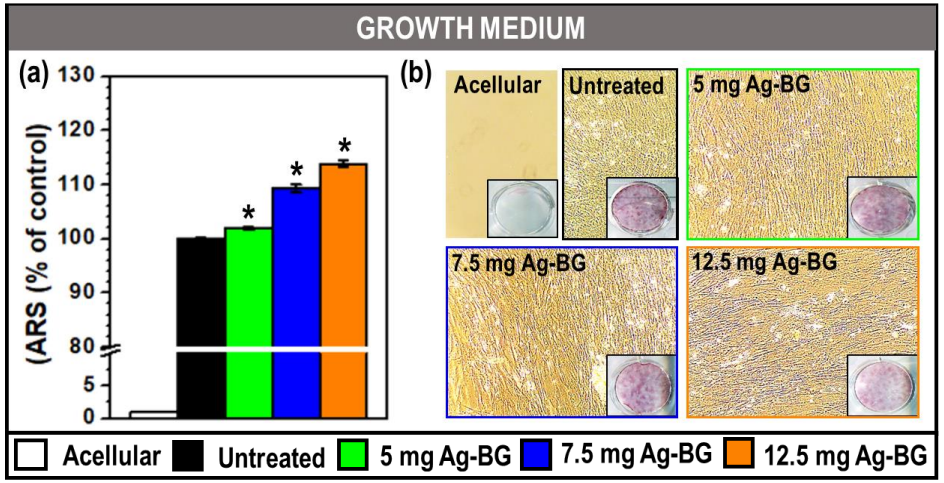
Can we regenerate bone?

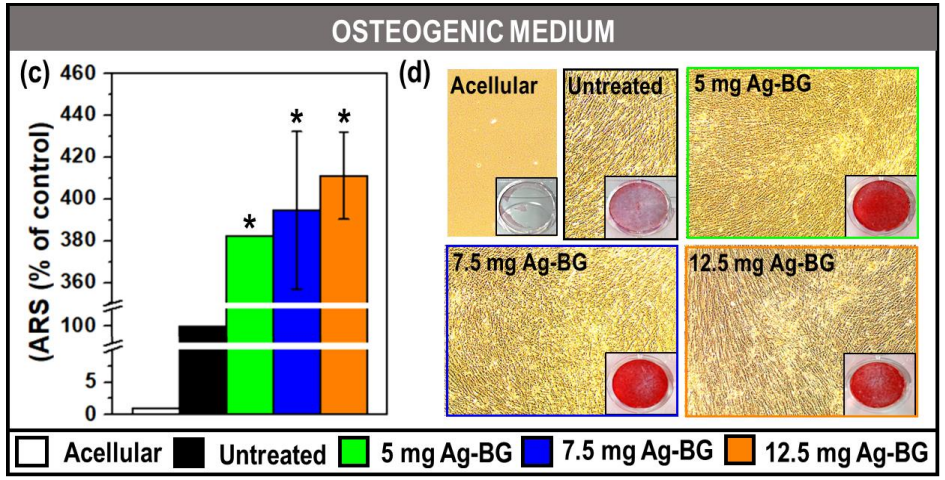
In vitro: human bone marrow stromal cells (hBMSC)



- hBMSC proliferate and differentiate when cultured with Ag-BG particles.







Pajares et. Al.Materials Science & Engineering C 120 (2021) 111693

NANOSCALE BIOACTIVE GLASS

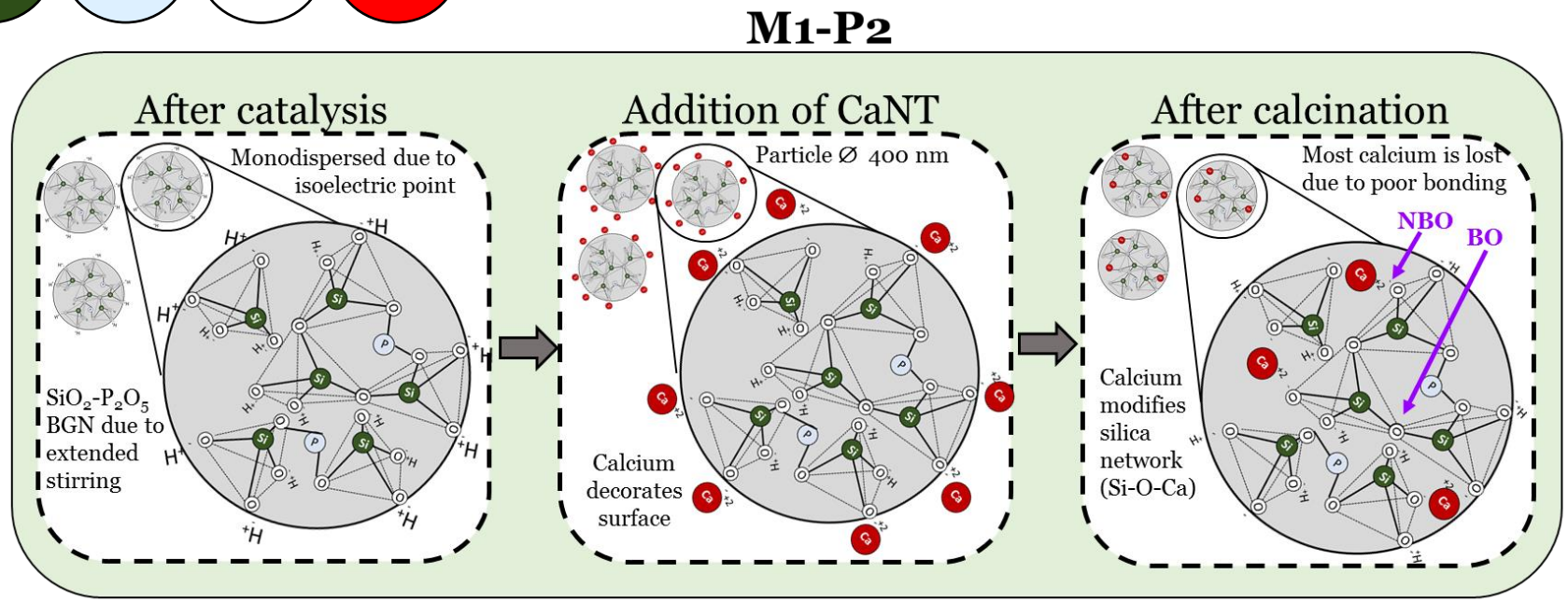
Why aiming for nanoscale?

- Improved cell-biomaterial interaction
- Faster bioactivity response: higher ion release and solubility
- Mimic better the host tissue
- Effective for therapeutic applications
- Stronger antibacterial activity
- Application as filler in composites

NANOSCALE BIOACTIVE GLASS

Si P O Ca

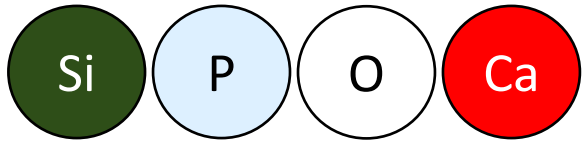
NBO= Non-Bridging Oxygen
BO= Bridging Oxygen



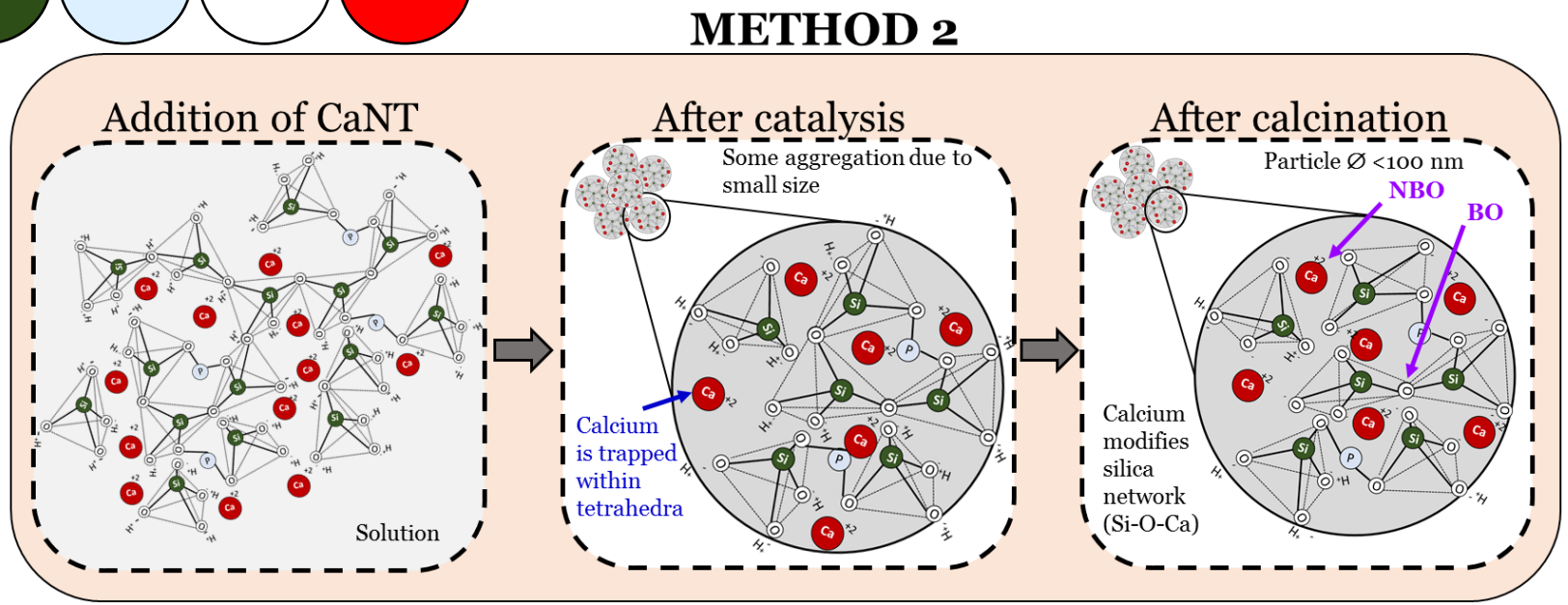
Incorporation of P by **balanced hydrolysis** in **methanol**

Pajares-Chamorro, N., & Chatzistavrou, X. (2020). *ACS omega*.

NANOSCALE BIOACTIVE GLASS



NBO= Non-Bridging Oxygen
BO= Bridging Oxygen



- CaNT was **incorporated before catalysis** to trap higher concentration of Ca ions before nucleation.
- Extended stirring **homogenized** the solution to incorporate P and Ca and **reduced size to 20 nm**

Pajares-Chamorro, N., & Chatzistavrou, X. (2020). *ACS omega*.

CONCLUSIONS

- Ag-BG is **strongly antibacterial** against MRSA.
- Ag-BG can **restore antibiotics** with mechanisms on the cell-wall.
- The inhibition mechanisms are correlated to the **degradation by-products of the material**.
- The **Stöber-like** protocol was successfully adjusted to achieve **nominal multi-oxide compositions in nanoparticles**.
- The **Ag-BGNs** of 10 nm diameter present dispersity.
- Ag-BGNs promote **faster cell proliferation** than Ag-BG.
- Ag-BGNs have **stronger antibacterial** properties than Ag-BG (as expected from the mechanism of action).