



TMDU
TOKYO MEDICAL AND DENTAL UNIVERSITY

Selenium Nanoparticles Concentrations on Osteoblastic Differentiation and Antimicrobial Effects on a Pathogen of Peri-Implantitis

Jason Hou, Yukihiro Tamura, Hsin-Ying Lu, Yuta Takahashi, Hidemi Nakata, Shinji Kuroda

Se



Introduction

Selenium Nanoparticles (SeNP) possess therapeutic properties exhibiting biological activities, low toxicity and excellent bioavailability.

- Potential use for Implant Coating.

The objective to investigate osseointegration and antibacterial properties through:

- **Cytotoxicity**
- **Mechanism of osteoblastic differentiation**
- **Antibacterial effect**

Methods & Materials

- SeNP concentrations: 0 (control), 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, and 2048 ppm (mg/L)
- MC3T3 osteoblast precursor cell & Porphyromonas gingivalis were used.
- Test includes: Proliferation assay, ALP activity and Alizarin Red Staining, RT-qPCR, and Optical Density against CFU/mL for bacteria concentration density

Results

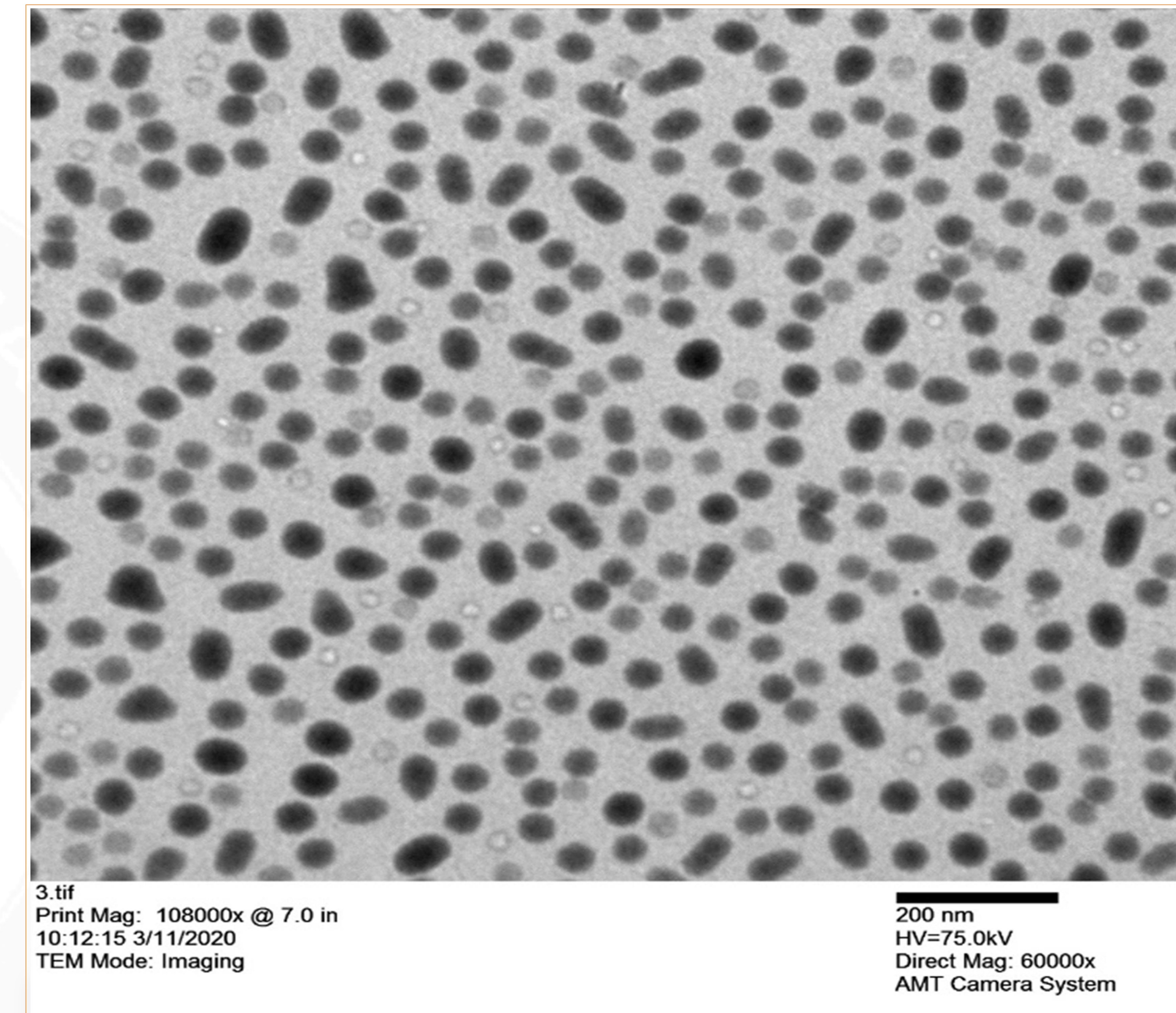
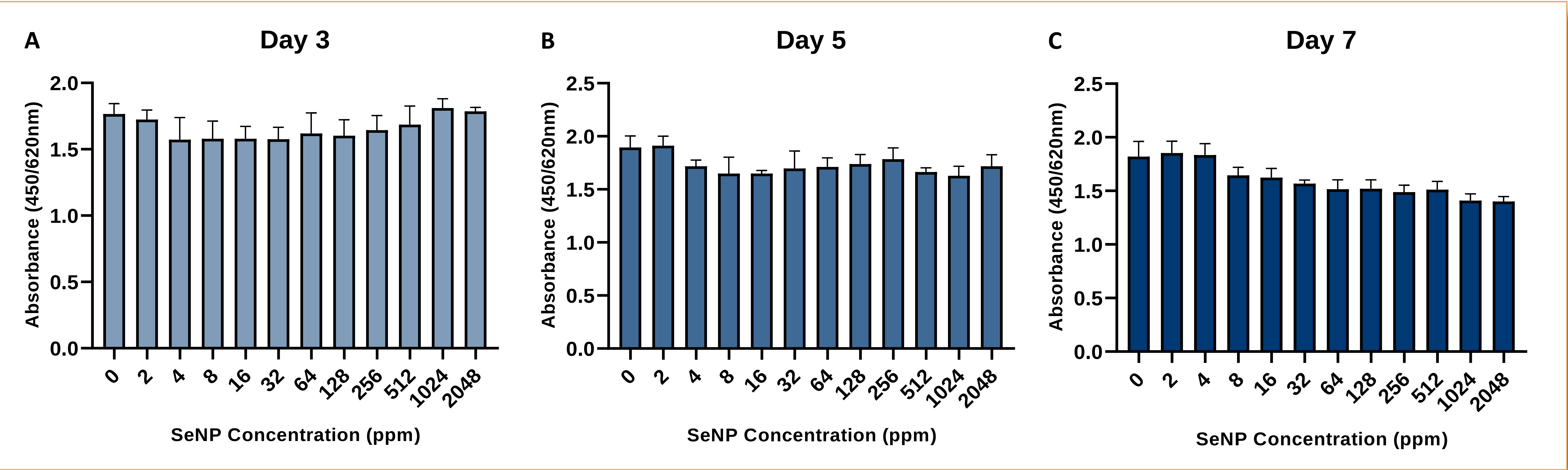


Figure 1

TEM scan

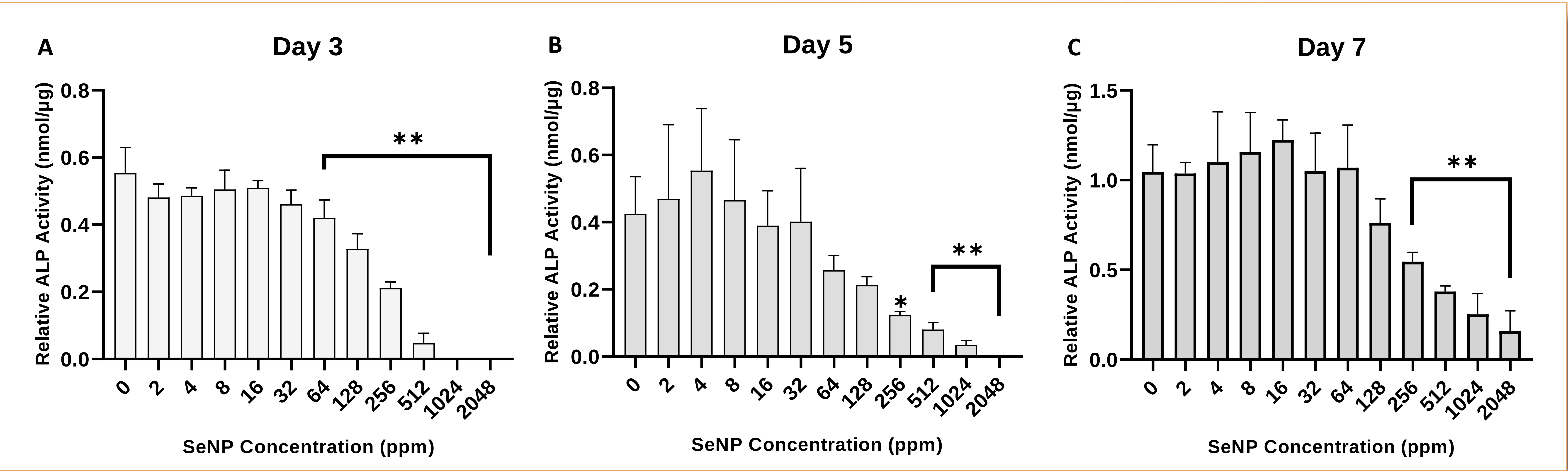
SeNP at a magnification of 60000x and voltage of 75.0 kV. Nanoparticles were mostly segregated from one another and were nearly spherical in shape.

Figure 2



Proliferation Assay

- **Day 3 and day 5**, no significant toxicity.
- **Day 7**, slight decrease in viable cells. However, there were no significance in comparison to Control.



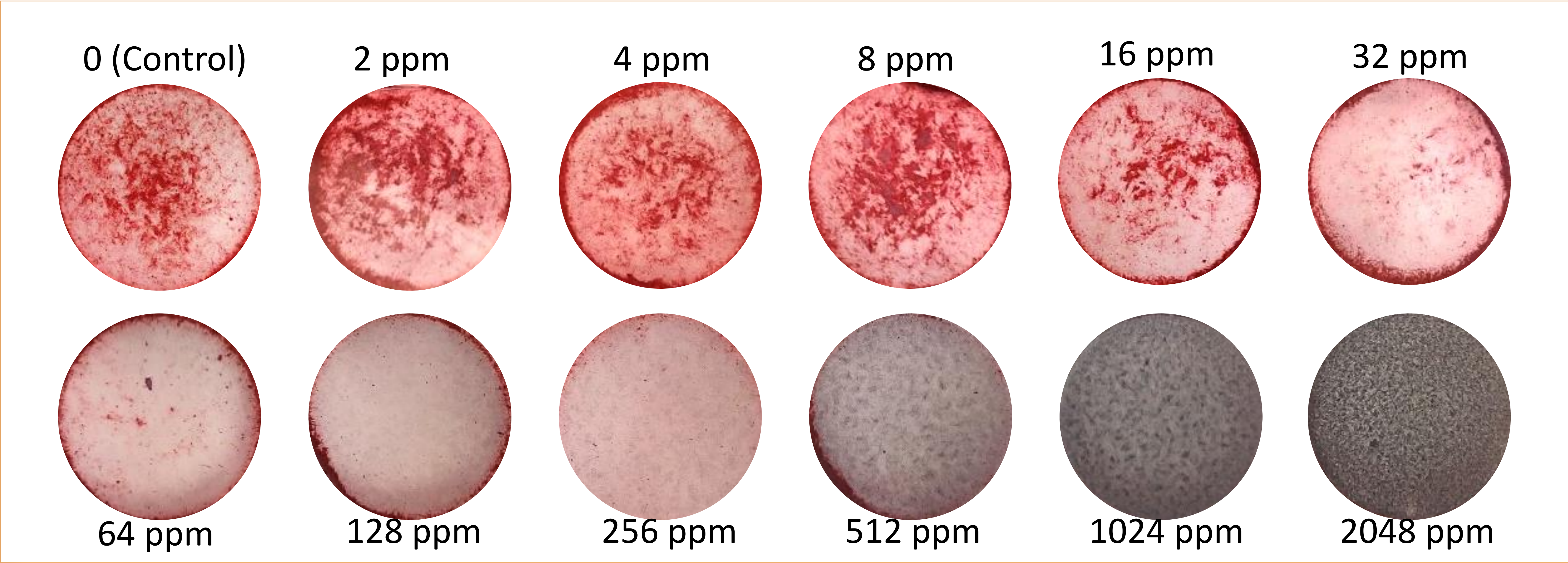
Relative ALP Assay

The relative ALP activity of SeNP concentrations from **2 to 32 ppm** seemed to not be significantly affected compared to the control in all three time-periods.

Figure 3

Selenium Nanoparticles Concentrations on Osteoblastic Differentiation and Antimicrobial Effects on Pathogen of Peri-Implantitis

Figure 4



Alizarin Red Staining

To observe the calcium deposition of MC3T3 cells treated with SeNP.

- **2 - 8 ppm**, staining comparable to the control.
- **16 - 32 ppm**, gradually showed a decrease in staining.
- **64 -2048 ppm**, there was no calcification.

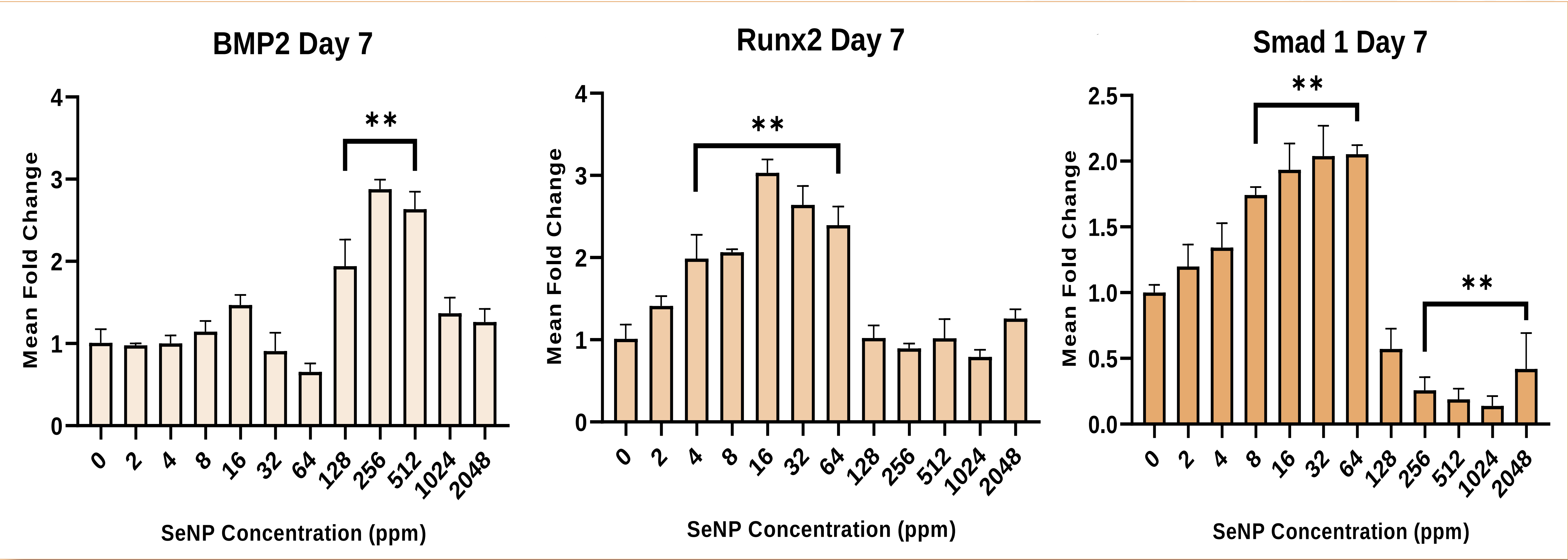
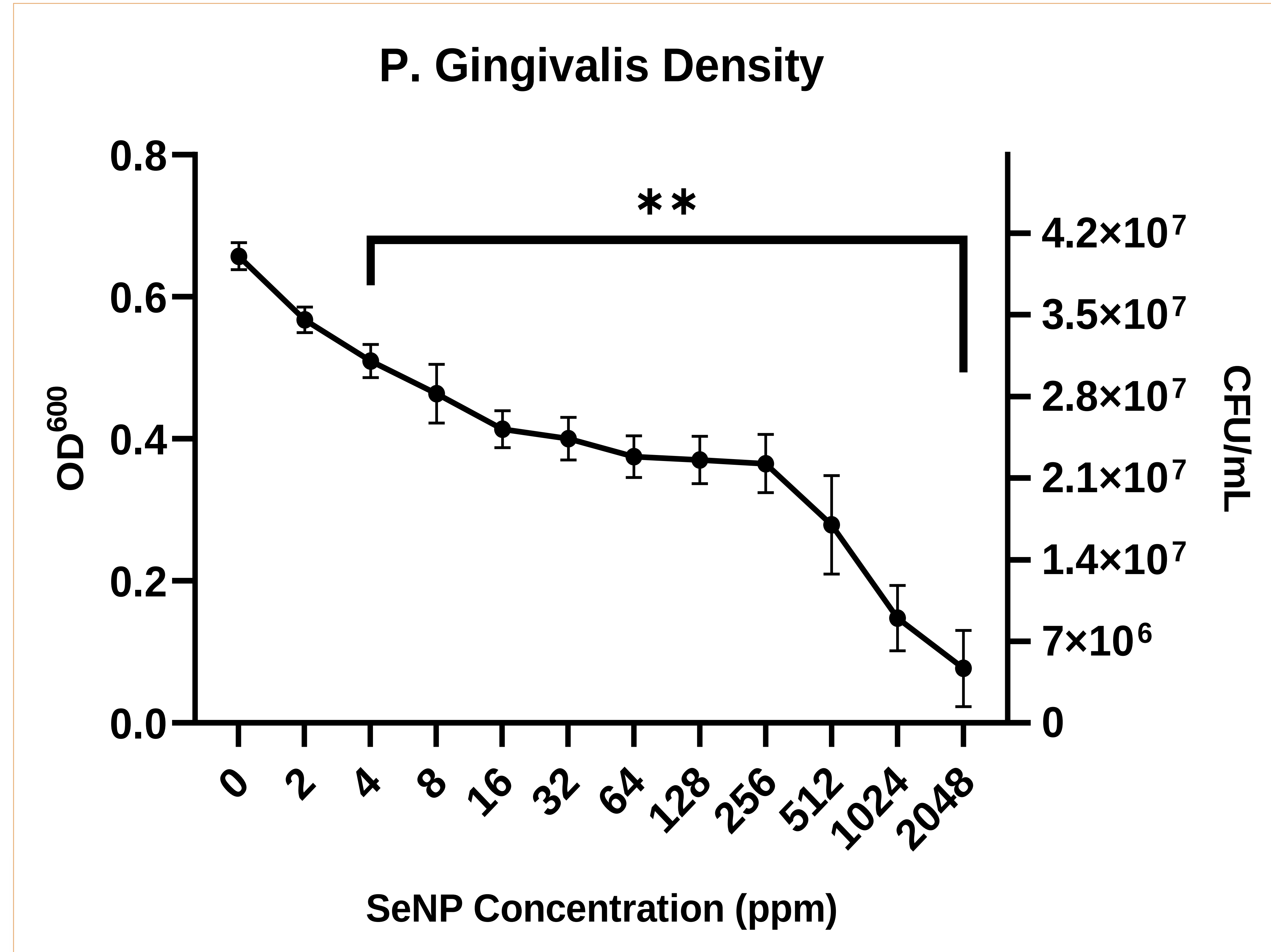


Figure 5

RT-qPCR

- **BMP-2:** 2 – 64 ppm normally regulated from, 128 – 512 ppm upregulated ($P < 0.01$).
- **Runx2:** 4 – 64 ppm higher than that in the control ($P < 0.01$).
- **Smad1:** 8 – 64 ppm were higher than in the control ($P < 0.01$), 256 – 2048 ppm significantly downregulated.

Figure 6



Bacterial Assay

- **4 ppm - 2048 ppm**, significant decrease in bacterial density.
- **4 ppm** = $2.92 \times 10^7 \pm 0.023$ CFU/mL
- **Control** = $3.91 \times 10^7 \pm 0.019$ CFU/mL,
- **Control and 4 ppm**: significant difference of 9.90×10^6 CFU/mL.

Conclusion

We initially hypothesized that a higher concentration of SeNP would promote osteoblastic differentiation while significantly inhibiting *P. gingivalis*.

However, our data showed:

- **SeNP (2 ppm to 16 ppm)** indicated no cytotoxicity.
- **High concentrations of SeNP** interfered with the osteoblastic lineage results in no mineralization or calcification.
- **SeNP concentration 4 – 2048 ppm** proved to be significant in inhibiting the growth of *P. gingivalis*.

Thus, **SeNP concentrations of 4 ppm to 16 ppm** are beneficial against pathogenic conditions while having no adversity towards osteoblastic differentiation in an in vitro scenario.