

Differently Charged Gold Nanoparticles Effects on Mesenchymal Stem Cell Differentiation

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Abstract

The cell niche refers to the microenvironment of the cell and its surrounding influences. Within this niche, cells are constantly receiving and exchanging subtle cues that lead to responses in cell response, survival and differentiation [1]. Nanomaterials are increasingly employed to study the subtlety of such cues on cell response and behaviour. In our study, gold nanoparticles (AuNPs) are used as they are easy to synthesize, possess relative biocompatibility and are versatile in their surface functionalization. Surface charges are also known to greatly influence the cellular behavior of cells, particularly in uptake dynamics [2]. As such, the manipulation of these features on AuNPs could direct the cells towards a targeted response and cell fate.

Firstly, stable AuNPs were synthesized from the gold salt HAuCl_4 and functionalized with alkanethiols to produce AuNPs with surface functional groups $-\text{NH}_2$ (positive charge), $-\text{COOH}$ (negative charge) and $-\text{OH}$ (neutral charge). Characterization of the synthesized AuNPs was carried out with transmission electron microscopy (TEM) and dynamic light scattering (DLS) for size determination. Zeta-potential analysis was performed for surface charge evaluation. Human mesenchymal stem cells (MSCs) were then treated with the different charged AuNPs and subsequently evaluated for cell response, viability and differentiation ability.

The AuNPs functionalized with the different charged groups were spherical with high zeta-potential in their respective charge (Fig. 1). Size determination of the particles also showed relative homogeneity in diameter size. Treatment with the AuNPs showed good cell viability after 3 days culture with the positive charged AuNPs showing higher particle uptake compared with the negative charged AuNPs. Long term exposure to the charged AuNPs in adipogenesis and osteogenesis induction media showed some differences in histological staining of selected osteogenic and adipogenic differentiation markers.

This study aims to evaluate how manipulation of one such feature, such as surface charge, could determine cellular response and would provide some insight on factors regulating cell sensing and regulation of stem cell fate.

References

- [1] Jiang J, Papoutsakis ET, *Adv Healthc Mater*, **2(1)** (2013) 25-42.
[2] Liu X, Huang N, Li H, Jin Q, Ji J, *Langmuir*, **29(29)** (2013) 9138-9148.

Figures

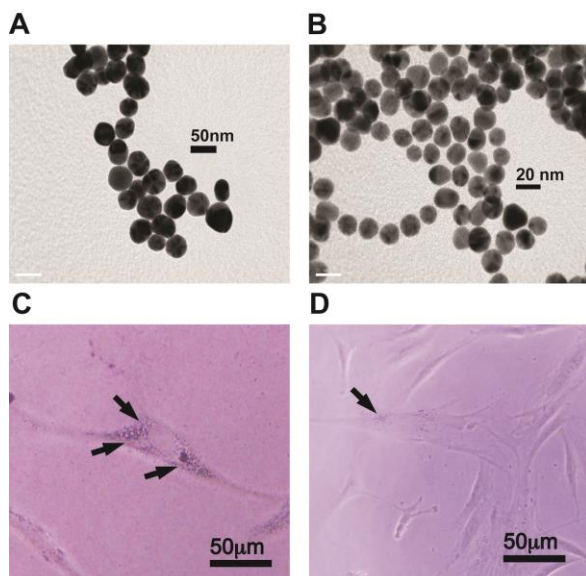


Fig. 1: Transmission electron microscopy (TEM) of synthesized AuNPs with different surface modification. (A) Positive charge AuNP modified with $-\text{NH}_2$ end group. (B) Negative charge AuNP modified with $-\text{COOH}$ end group. MSCs treated with (C) AuNP- NH_2 and (D) AuNP- COOH at 1nM concentration for 72h. Arrows indicate presence of AuNPs in cells. Scale bar as indicated in the figure.