Novel superparamagnetic iron-doped hydroxyapatite nanoparticles to direct cellular fate

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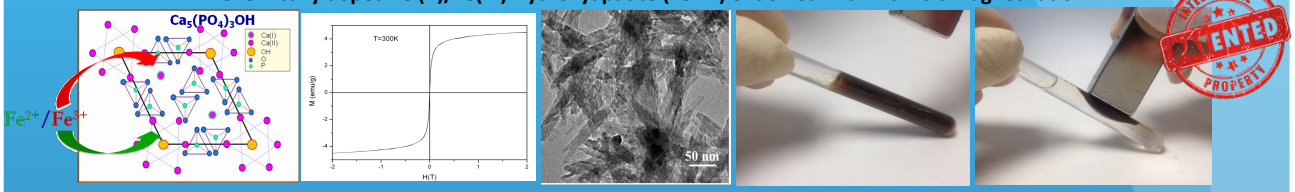
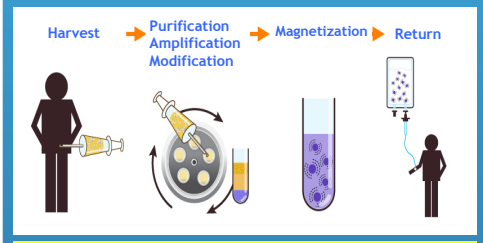
Strong coupling between nanotechnology and cell/molecular biology leaded to a breakthrough in medicine in the last decade due to the exiting opportunities in designing and developing a tailored approach in response to different diseases. Magnetic nanoparticles (NPs) have attracted the attention of scientific community for biological and medical purposes as promising materials in cells, drug or gene delivery, DNA/biomolecules separation, hypothermal treatment of tumours, contrast agents for imaging[1], and recently in tissue engineering and theranostic applications[2,3]. Here novel biomimetic, fully biodegradable and cytocompatible NPs fabricated by doping hydroxyapatite (HA) with Fe ions (FeHA), avoiding the presence of poorly tolerated magnetic secondary phases and any coating, were proposed for different applications in medicine.

Chemically doped Fe (II)/Fe(III) Hydroxyapatite (FeHA) endowed with intrinsic magnetization

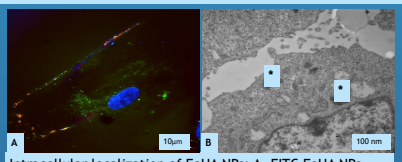


ADVANCED CELL THERAPY



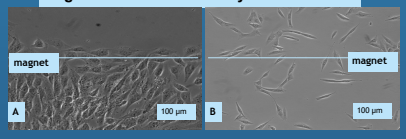
IMPROVEMENT OF CELL DELIVERY AND RETENTION

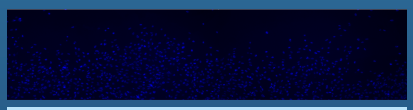
FeHA NPs inetrnalized by Mesenchymal Stem Cells (MSCs)



Intracellular localization of FeHA NPs: A. FITC FeHA NPs (green), cell nucleus (blue) and endosome (red); B. TEM image of internalized NPs (*).

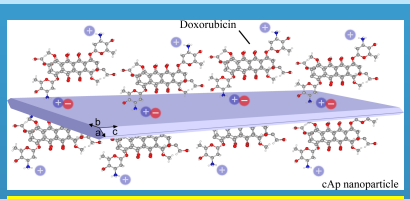
Magnetic MSCs attracted by a SMF



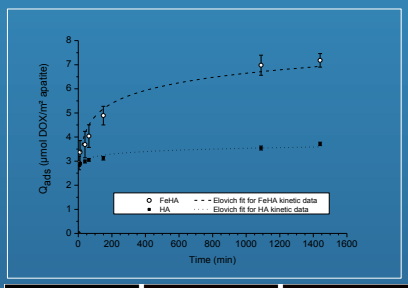


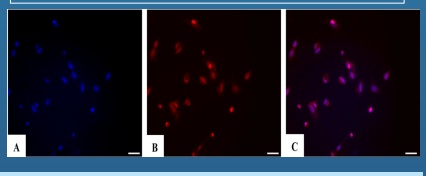
Magnetic MSCs aligned due to a magnet application to the flask bottom side. (C) and (D) showed a random distribution of HA NPs cells and cells only groups. (E) Merge of fluorescence images of aligned FeHA NPs magnetic cells. In blue cell nuclei.

CANCER THERAPY



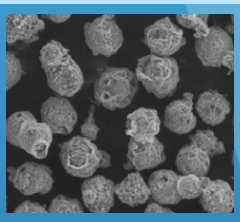
TARGETED DRUG DELIVERY CAN PROVIDE THERAPEUTICALLY EFFECTIVE DOXORUBICIN (DOX) RELEASE DIRECTLY AT THE TUMOR SITE IMPROVING THE CANCER TREATMENT





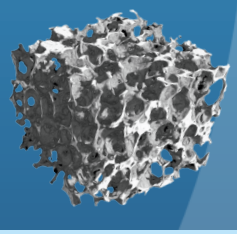
(i) FeHA displayed higher affinity for DOX due to good affinity of the drug for the iron cations
(ii) The stability of the bonding between DOX and FeHA was stronger compared to HA
(iii) The release of DOX from FeHA was also assessed in the presence of a Pulsed Electro Magnetic Field
(iv) *in vitro* assays demonstrated that DOX loaded on HA and FeHA was able to exert its cytotoxic activity on SAOS-2 cells at the same level as free DOX

GROWTH FACTORS RELEASE



FeHA-collagen Microspheres + Growth factors/ drugs

Loaded into 3D scaffold



TISSUE ENGINEERING APPLICATIONS
Prolonged release of biomolecules

REFERENCES
1) Panseri et al. J Biomed Nanotechnol. 2016. 12, 909-921
2) Iafisco et al. J Mater Chem B. 2016, 4, 57-70.
3) Fernandes et al. Mater Sci Eng C. 2017. 77, 613-623.