*Title:* Nanotechnology applications for innovative therapeutic approaches

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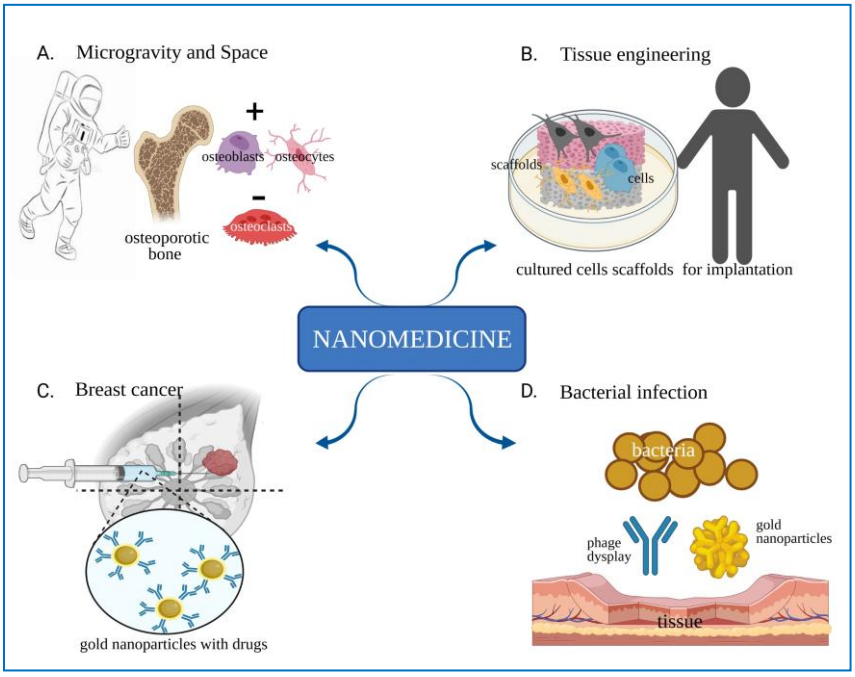
*Background*

The use of nanotechnology in medicine – referred to as **nanomedicine** - offers some exciting possibilities. It could revolutionize the way we detect and treat damages to the human body and diseases in the future, and many techniques only imagined a few years ago are making remarkable progress towards becoming realities. In view of this, the proposed studies aim to investigate the applications of nanotechnology for innovative therapeutic approaches in **4 different research fields:**




**A. Osteoporosis treatment in simulated microgravity and on International Space Station (ISS).** In this research line we are interested in studying the Fibroblast growth factor 23 (FGF23)/Klotho axis in microgravity. FGF23 the most important bone hormone, is known to play a key role in the complex network between the bones and other organs: FGF23 seemed to be involved in the progression of primary osteoporosis. A particular emphasis will be put in the FGF23, together with its co-receptor alfa-Klotho (sKL) and their specific miRNA; inflammatory cytokines and anti-inflammatory omega-3 PUFAs; and variations of the mtDNA copy number in the blood and urine of astronauts in pre-, in- and post-flight conditions.

**B. Biological characterization of nano-micro/scaffolds for regenerative medicine**. We aims to investigate the interaction of human mesenchymal stem cells (hMSCs) with nano/microelectrospun fibers/scaffolds and study their differentiation to osteoblasts in different experimental conditions

**C. Biological characterization of nanosystems conjugated with drugs for treatment of breast cancer**. The basic idea is the characterization of polymer coated gold nanoparticles conjugated to a specific drug/antibody and the biological evaluation of their efficacy on *in vitro* cells tumor models. We are also investigating the effect of these developped nanosystems by using a 3D *in vitro* models (spheroids) and a 3D Bioprinting models of breast cancer tumor.

**D. Biological characterization of nanosystems for treatment of respiratory tract infections.** Respiratory tract infections (RTIs) are the third leading cause of morbidity and mortality worldwide. For RTIs infection, we recently developed a patented new class of glycosylated nanoparticles, defined as mucosomes, made of mucin with mucoadhesive properties. Mucosomes could represent an innovative class of multifunctional drug delivery nanoplatforms, bringing innovative features with respect to liposomes or polymeric NPs which represent the state of art. To validate the antimicrobial and immune responses performance of the newly developed mucosomes (with/without different drugs), a 3D air-liquid interface (ALI) platform composed of co-cultures of human epithelial cells and alveolar macrophages, infected or not withbacterial strains will be investigated.

**Techniques to be used by the Ph.D student:** Biological, biochemical (cromatography, eletrophoresis, western blotting and dot blot) molecular biology (RT-PCR and qRT-PCR) techniques; preparation of samples for Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), CryoEM, Confocal laser scanning microsocopy (CLSM) and Time laspse; cytofluorimetric analysis; cell cultures and bacterial cultures; simulated microgravity set up; DLS, Zeta Potential, Spectrofotomer reading; Proteomic approaches.

(Graphycal abstract created with BioRender.com)