PhD Course in *Models and Methods for Materials and Environmental Sciences* – Cycle XXXVII
PhD Student: M.Sc. Fraulini Francesca
Tutor Prof. Gigliola Lusvardi

Bioactive materials: design, functionalization, in vitro-in vivo application

Bioceramics, and in particular bioactive glasses (BGs), are biomaterials with the peculiar ability of forming an apatitic phase, chemically and structurally similar to hydroxyapatite, the main inorganic component of bones. For this reason, to date the primary application of BGs has been related to hard tissue regeneration and mainly in the form of a glass particulate, but an emerging field of BGs exploitation is soft tissue regeneration, for instance wound healing applications. Present-day research also focuses on improving the BGs performances, conferring them desirable properties and inducing specific effects in the biological environment; this has led to develop new synthesis methods to achieve different morphologies and to include biologically useful elements in the composition, such as therapeutic inorganic ions (TIIs). Among these, cerium and its compounds have attracted attention for their therapeutic applications as antioxidant, bacteriostatic, antiemetic and antitumor agents.

Recent studies conducted within the Prof. Lusvardi's research group led to the synthesis and characterization of cerium-doped mesoporous bioactive glasses (Ce-MBGs) functionalized with gentamicin, a broad-spectrum antibiotic. The synthesized materials proved to be multifunctional drug delivery systems (DDS) with controlled pharmaceuticals release, which can benefit disjointly from the antioxidant properties provided by cerium doping, the antibacterial properties of and the bioactivity of MBGs.

Having seen the above cited results, the aim of my PhD project will be the exploitation of said Ce-MBGs in both hard and soft tissue engineering. My objective will be to broaden and deepen the application of MBGs in hard tissue regeneration and investigate which changes in morphology and composition would make them suitable for wound healing applications. As for the first point, I would functionalize the materials with new useful biomolecules, such as other antibiotics or anti-inflammatory drugs, to exploit their drug delivery ability. Regarding the latter point, porous 3D scaffolds and ceramic fibers have been reported to be suitable for wound healing applications. My goal would be to optimize the Ce-MBGs composition and to process them into 3D highly porous scaffolds. In addition, the same composition can be used to produce ceramic fibers by sol-gel method. The structures could then be functionalized with the desired biomolecules. By doing this, it would be possible to transport the drug delivery ability of the glasses into a new application field. Finally, I will have the opportunity to test the angiogenic properties of these Ce-doped materials, that are extremely helpful to overcome the lack of vascularization at the implant site, which is still one of the most important problems tissue engineering has to face.