Magnetic Assembling of 3D cellular architectures

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The employment of magnetic scaffolds for tissue engineering, pioneered recently by our group, has become an active research topic worldwide. Such scaffolds are able, via magnetic driving, to attract and take up growth factors, stem cells or other bio-agents bound to magnetic particles.
This intruing potential is exemplified here via the three dimensional magnetic patterning of two different cell types. The 3D assembling was realized in vitro inside an additive manufactured magnetic scaffold, as an advanced solution for tissue engineering constructs. The magnetization of cells with bio-compatible magnetic nanoparticles completely preserved the cell viability. The presence of non-homogeneous magnetic gradients inside the scaffold permitted to realize separate arrangements of vascular and mesenchymal stem cells on the opposite sides of the scaffold fibers, as a conceptual precursor for the vascularized tissue. The magnetization of the scaffold amplified the guiding effects by an additional trapping of cells due to short range magnetic forces. The mathematical modeling confirmed the strong enhancement of the magnetic gradients and their particular geometrical distribution near the fibers, defining the preferential cell positioning on the micro-scale. The manipulation of cells inside suitably designed magnetic scaffolds represents thus a unique solution for building complex cell assemblies organized in a biologically adequate arrangement.