

OL 5 - A New Design Architecture for Tissue Engineering

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The multilayer structure of living tissues such as: cornea, blood vessels, intervertebral discs and skin, led us to consider the elaboration of biomaterials with new architectures to answer the difficulties of complex tissue regeneration. Thanks to our knowledge on chitosan based physical hydrogels, we propose a multi-membrane onion-like structured material processed from physico-chemical perturbations of a physical hydrogel of chitosan.

This architecture was designed through a multi-step neutralization performed on an alcoholic gel of chitosan. Then, the polymer network underwent a volume transition in response to changes in solvent composition, pH and ionic strength. This transition resulted in the competition between repulsive forces expanding the polymer network, and attractive interactions responsible for shrinking. The parameters controlling the base diffusion and the contraction of polymer chains appeared to be the key factors of such a multimembrane structure.

In contrast to the “layer-by-layer” self-assembly process, our materials are only constituted of one polymer (chitosan) and water. Moreover the multi-membrane structure leads to the formation of inter-membrane spaces useful to allow subsequent cell introduction and proliferation.

Previous studies reported that chitosan is bio-active, biodegradable, and has a good bio-compatibility. Moreover the absence of chitosan in mammals makes it a good candidate since it is less prone to enzymatic degradations. Thanks to the biological properties of chitosan; the adapted mechanical properties of such physical hydrogels and this new architecture, the cells could differentiate and proliferate within our multimembrane system as an enclosed “bioreactor”.

This onion-like architecture could have a great potential for tissue engineering. Indeed the way of pluricellular cultures allows us considering the possibility of complex tissue regeneration (in vivo or in vitro) such as the bone-cartilage junction and could open the way for the entire organ growing, as blood vessels, inter-vertebral discs, etc....