“Bioactive glasses meet 3D bioprinting: advances and challenges for tissue engineering applications”

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Abstract

In 2021 we celebrate 50 years of bioactive glass (BG), the first man-made material capable to bond to tissues, discovered by the late Prof. Larry L. Hench [1]. The traditional applications of BGs have been in bone substitution, for example as bone defect filler, small bone and dental implants and as coatings for orthopedic applications. BGs are being increasingly considered in the tissue engineering (TE) field, expanding from bone to soft TE and wound healing. Such TE applications exploit the biochemical interactions occurring at the interface between BG surfaces and the biological environment, which involve the (controlled) release of biologically active ions to activate specific cellular pathways [2]. As an example, the effect of selected metallic ions on vascular endothelial growth factor release from stem cells will be discussed demonstrating the angiogenic potential of such biomaterials. In model cell culture studies, the variation of ion concentration in the medium and the time dependent effects on stem cells will be discussed, which is required for the comprehensive assessment of the biological performance of BGs with implication for their clinical translation.

In this context, applications of BGs (e.g. as mesoporous nanoparticles) in the field of 3D bioprinting (biofabrication) have been emerging in the last few years expanding the interest of BG in TE. In the second part of the presentation, the progress in the development and characterization of TE scaffolds made purely from BGs or by combining BGs and biopolymers, including their application in 3D bioprinting approaches, will be discussed. Examples of such applications will be presented highlighting the novel developments of hydrogel-bioactive glass composites as innovative multimaterial bioinks for cell encapsulation and for biofabrication of cell laden scaffolds of increasing complexity [3]. The author’s views on the challenges and opportunities for further research in the field will be presented.

References

[1] L.L. Hench, et al., Bonding mechanisms at the interface of ceramic prosthetic materials, *J. Biomed. Mater. Res.* 5 (1971) 117–141.

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[3] S. Heid, A. R. Boccaccini, Advancing bioinks for 3D bioprinting using reactive fillers: A review, *Acta Biomater.* 113 (2020) 1-22.