3D Bioprinting and Nanotechnology Applications for Tissue Engineering: State of the Art

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Regenerative medicine and tissue engineering are two crucial technologies used nowadays. While regenerative medicine deals with the process of replacing, engineering or regenerating human cells, tissues or organs to restore normal functions, tissue engineering aims to develop biological substitutes that restore, maintain and improve the lost or damaged function of tissues. Three main components of tissue engineering are scaffolds, cells and signal molecules that may be added to the 3D structure to mimic better the natural tissue of interest. Scaffolds can be prepared as 2D or 3D structures through various methods such as freeze drying, phase separation, gas foaming, solvent casting and some nanofabrication techniques. As some of these methods do not fully mimic the inherent structure of the tissue, lately fabrication techniques that result in 3D structures such as 3D bioprinting and electrospinning have been used for tissue engineering purposes.

3D bioprinting has shown to be a promising strategy for preparing on-demand 3D models as it assembles biomaterials (with or without cells in it) to create various biomedical products. Some of the 3D bioprinting technologies used are inkjet-based bioprinting, extrusion-based bioprinting, laser-assisted bioprinting, and stereolithography bioprinting [1, 2]. With 3D bioprinting generation of highly complex cellularized constructs is possible. Combination of bioprinting and nano-biomaterials improves critical weakness of these manufacturing processes and enhances their efficiency by spatially arranging nano-features [1]. On the other hand, electrospinning is another method used to prepare three-dimensional nano-microfibrous structures. The process includes the use of electric forces to draw charged threads of polymeric solutions up to fiber diameters in the order of some hundred nanometers. It has found a wide range of applications for various tissues such as cartilage, tendon, bone, meniscus and skin [3].

Through this study we will highlight how the use of nanobiomaterials and polymeric scaffolds in 3D bioprinting and electrospinning techniques can lead to promising strategies for tissue engineering applications.

References

[1] Di Marzio N, Eglin D, Serra T and Moroni L, Front. Bioeng. Biotechnol., 8 (2020) 326.
[2] Zhang S., Chen X.,Shan M., Hao Z., Zhang X., Meng L., Zhai Z., Zhang L., Liu X., Wang X., Biomimetics, 8 (2023) 94.
[3] Ndreu A, Nikkola L, Ylikauppila H, Ashammakhi N, Hasirci V., Nanomedicine, 3 (1), (2008), 45-60.