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Selection and Preparation of High Performance, Natural and Cost-Effective Hydrogel as a Bio-Ink for 3D Bio-Printing and Organ on Chip Applications

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Abstract : Background: Three-dimensional (3D) bio-printing has become a versatile and powerful method for generating a variety of biological constructs, including bone or extracellular matrix scaffolds endo- or epithelial, muscle tissue, as well as organoids. Aim of the study: Fabricate a low cost DIY 3D bio-printer to produce 3D bio-printed products such as anti-microbial packaging or multi-organs on chips. We demonstrate the alignment between two types of 3D printer technology (3D Bio-printer and DLP) on Multi-organ-on-a-chip (multi-OoC) devices fabrication. Methods: First, Design and Fabrication of the Syringe Unit for Modification of an Off-the-Shelf 3D Printer, then Preparation of Hydrogel based on natural polymers Sodium Alginate and Gelatin, followed by acquisition of the cell suspension, then modeling the desired 3D structure. Preparation for 3D printing, then Cell-free and cell-laden hydrogels went through the printing process at room temperature under sterile conditions and finally post printing curing process and studying the printed structure regards physical and chemical characteristics. The hard scaffold of the Organ on chip devices was designed and fabricated using the DLP-3D printer, following similar approaches as the Microfluidics system fabrication. Results: The fabricated Bio-Ink was based onHydrogel polymer mix of sodium alginate and gelatin 15% to 0.5%, respectively. Later the 3D printing process was conducted using a higher percentage of alginate-based hydrogels because of it viscosity and the controllable crosslinking, unlike the thermal crosslinking of Gelatin. The hydrogels were colored to simulate the representation of two types of cells. The adaption of the hard scaffold, whether for the Microfluidics system or the hard-tissues, has been acquired by the DLP 3D printers with fabricated natural bioactive essential oils that contain antimicrobial activity, followed by printing in Situ three complex layers of soft-hydrogel as a cell-free Bio-Ink to simulate the real-life tissue engineering process. The final product was a proof of concept for a rapid 3D cell culturing approaches that uses an engineered hard scaffold along with soft-tissues, thus, several applications were offered as products of the current prototype, including the Organ-On-Chip as a successful integration between DLP and 3D bioprinter. Conclusion: Multiple designs for the organ-on-a-chip (multi-OoC) devices have been acquired in our study with main focus on the low cost fabrication of such technology and the potential to revolutionize human health research and development. We describe circumstances in which multi-organ models are useful after briefly examining the requirement for full multi-organ models with a systemic component. Following that, we took a look at the current multi-OoC platforms, such as integrated body-on-a-chip devices and modular techniques that use linked organ-specific modules.

Keywords : 3d bio-printer, hydrogel, multi-organ on chip, bio-inks
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