Handbook of 3D Printing in Biomedical Applications

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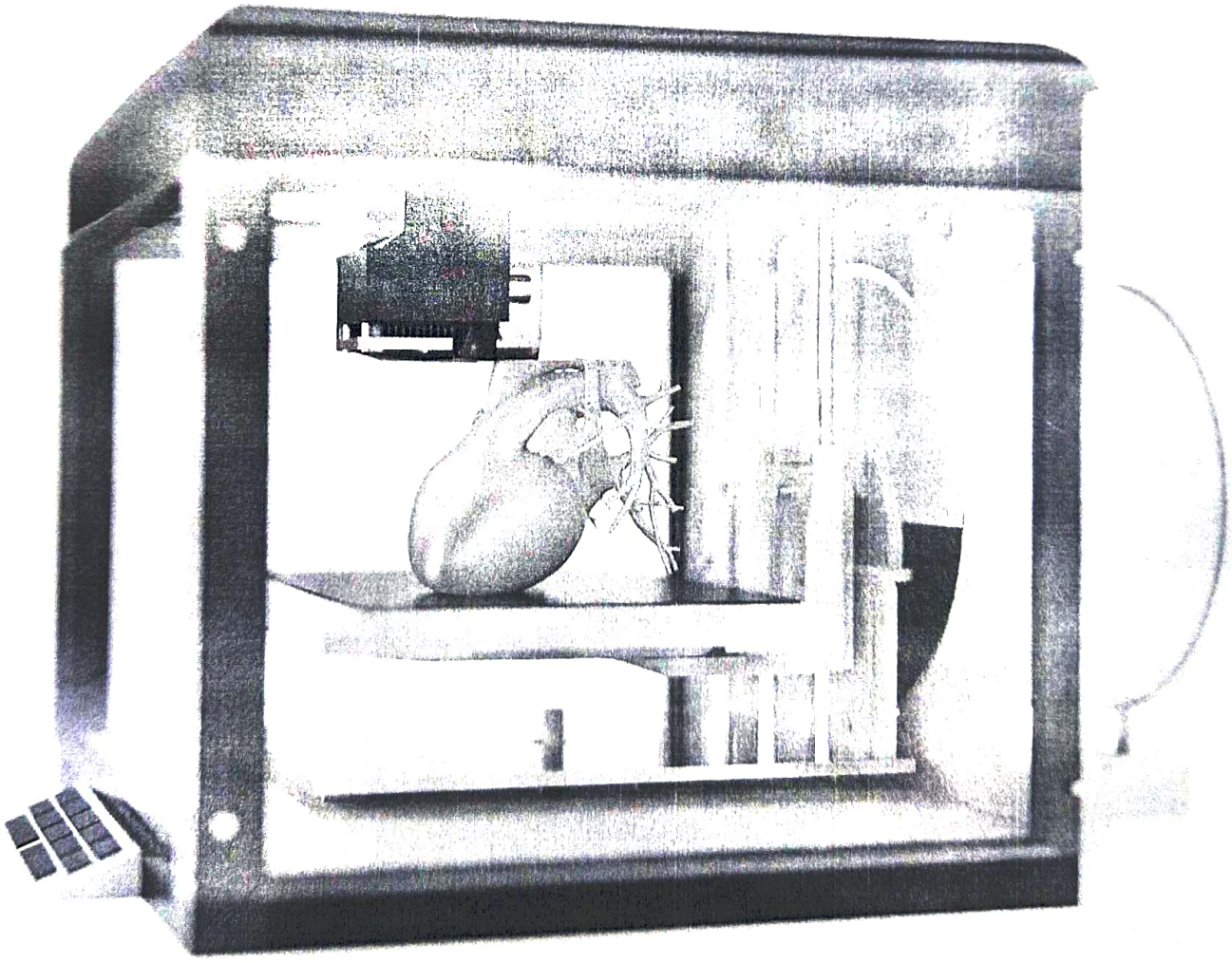

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12.1 INTRODUCTION

Biofabrication is a developing field of research that involves the production of tissue constructs with a hierarchical structure. Some examples of conventional biofabrication processes are particle leaching, freeze-drying, electrospinning, and micro-engineering (Bajaj et al. 2014; Gungor-Ozkerim et al. 2018). While these methods can create three-dimensional (3D) structures using various biomaterials, they often have a restricted ability to consistently reproduce and adapt their production processes. Biofabrication is the process of creating biologically functional products using automated methods that entail the arrangement of living cells, bioactive molecules, and cell aggregates (Groll et al. 2016; Blanco et al. 2024).

In recent times, 3D bioprinting has become a new method of biofabrication. The automated deposition process allows for better control over the structure of the created tissue constructs. This method also offers high reproducibility (Murphy and Atala 2014; Zhang et al. 2017; Zhang YS et al. 2016). 3D bioprinting is a process that uses biomaterials and living cells to create 3D tissue structures with predetermined shapes and patterns. Despite being in the early phases of research, 3D bioprinting's adaptability has rapidly increased its applicability in tissue engineering (Wang et al. 2024; Carrow et al. 2015).

The common 3D bioprinting methodologies (Figure 12.1) (Vanaei et al. 2021) are classed as: fused deposition model, Vat polymerization, inkjet bioprinting, extrusion-based bioprinting, and laser-assisted bioprinting. In addition, there are other specialized bioprinting systems that have been created with unique functions tailored to different applications (Wüst et al. 2011; Dababneh and Ozbolat et al. 2014; Khalil and Sun 2009; Wang et al. 2015). These techniques entail programming 3D structures in a computer-aided manufacturing/computer-aided design (CAM/CAD) system. Within various bioprinting methods, the bioinks play a crucial role as they are cross-linked or stabilized during or right after the bioprinting process. This facilitates the formation of the desired tissue structures. The specific application, including the target tissue, cell type, and bioprinter, determines the choice of bioink. Although there have been notable advancements in bioprinting techniques, the practical use of these techniques has been hindered by the absence of suitable bioinks. These bioinks must

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