Commentary
Volume 11:11, 2021

Journal of Bioengineering & Biomedical Science

ISSN: 2155-9538

Open Access

Tissue/organ Regeneration Engineering with 3D Bio-printing Technology

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Commentary

The human body's ability to regenerate is limited. Obtaining tissue from the same individual or transplanting from cadavers are the only current therapy options for replacing damaged tissue and organs. These treatments have drawbacks, including as donor site morbidity and donor shortage. These situations have heightened the demand for biological alternatives, and researchers in the disciplines of tissue engineering and regenerative medicine have been working to meet this need. Regenerative Engineering is characterised as the convergence of advanced materials science, stem cell science, physics, developmental biology, and clinical translation towards the regeneration of complex tissues and organ systems. Advanced manufacturing is part of the regenerative engineering concept.

Three-dimensional (3D) bioprinting is a cutting-edge technique for creating biological constructions with hierarchical architecture that resembles their natural counterparts. Artificially developing living functioning tissues could fill a gap in tissue replacement and organ transplantation. With this viewpoint, bioprinting is gaining widespread recognition among doctors and researchers throughout the world as a feasible tool for improving the lives of diseased people. 3D Bioprinting is a type of additive manufacturing that prints live structures layer by layer, mimicking the behaviour of natural living systems, using cells and other biocompatible materials as "inks," also known as bioinks.

Bioink is one of the most important prerequisites for 3D bioprinting. It's made up of biomaterials, cells, and other necessary components. In the near future, the technology could be utilised to fabricate functional human tissue or organs such as the heart, liver, skin, and bones, as well as create microfluidic models of organs-on-a-chip. Despite the benefits and convenience offered by 3D bioprinting, the state-of-the-art technology faces several challenges, including tissue vascularization, gas and nutrient exchange, biocompatibility and biodegradability of the substrate material, shape-fidelity, and functionality preservation of the printed tissue. Because of their biocompatibility and adjustable physio-chemical properties that may be changed to suit the ECM structure and development, synthetic and natural polymers like as alginate, gelatin, collagen, Polyethylene Glycol (PEG), Hydroxyapatite, and others have been used to this end.

Tissue damage and degeneration is a very typical occurrence in humans; nevertheless, the human body's regenerative capacities are insufficient to deal with this stress. Traditional treatments for these diseases rely on tissue or organ transplantation, which is reliant on the availability of a donor, which can be difficult to come by, and comes with the risk of graft rejection owing to an immunological reaction. Tissue engineering and regenerative medicine are two topics that are quickly developing to address these problems.

3D bioprinting, in general, is based on layer-by-layer exact positioning of biological constituents, biochemicals, and living cells, as well as spatial control of the placement of functional constituents of the manufactured 3D structure.

As previously stated, 3D bioprinting is based on three key approaches:

I. Bio mimicry or biomimetics,

II. Autonomous self-assembly, and

III. Mini-tissue building blocks.

Due to its capacity to spatially manage the positioning of cells, biomaterials, and biological molecules for tissue or organ regeneration, bioprinting technology has recently gotten a lot of attention. Bioprinting has been utilised to make 2D and 3D structures for a variety of applications, including scaffolding and tissue constructs for tissue regeneration. Valve replacement, whether mechanical or biological, is frequently required in patients with valvular heart disease. Complications such as mechanical failure and calcification are common with these prosthetic valves. As a result, a variety of measures, including the use of bioprinting technology, have been proposed to enhance the outcomes.

Bioprinting methods have been created and used in a variety of life sciences applications, ranging from investigating biological systems to fabricating tissues and organs for implantation. These technologies have been shown to deliver cells, biomaterials, and biological molecules safely and precisely to specific sites. Simple tissue structures can be bioprinted, according to studies; nevertheless, more complicated and composite tissue structures, such as solid organs, remain a difficulty. While the idea of printing entirely functional organs may seem far-fetched at the moment, these technologies have huge potential and promise to become an important tool in the area of medicine in the future. Many technological obstacles must be overcome in order to further develop and utilise these technologies for therapeutic usage.

How to cite this article: Pullela, Sushma. "Tissue/organ Regeneration Engineering with 3D Bioprinting Technology." J Bioengineer & Biomedical Sci 11(2021): 270.

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Received 08 October 2021; **Accepted** 22 October 2021; **Published** 29 October 2021