

Advances in bioprinting technology from layer-by-layer cell printing to volumetric bioprinting

Riccardo Levato

Assistant Professor, Department of Orthopaedics, University Medical Center Utrecht, Regenerative Medicine Center Utrecht, and Department of Equine Sciences, Utrecht University, Utrecht, The Netherlands

Abstract

The function of living tissues is intimately linked to their complex architectures. Biofabrication technologies are rapidly advancing as powerful tools capable to capture salient features of tissue composition and thus guide the maturation of engineered construct into mimicking functionalities of native organs. In biofabrication, multiple cell types and biomaterials are patterned in three dimension through automated processes, either via bioprinting or bioassembly. The current paradigm in bioprinting relies on the additive layer-by-layer deposition and assembly of repetitive building blocks, typically cell-laden hydrogel fibers or voxels, single cells, or cellular aggregates. Since its initial conception and its first implementations through inkjet printing technologies, bioprinting rapidly introduced a new toolset for bioengineers and material scientists to produce new strategies to restore the function of impaired tissues. In this contribution, both currently available and innovative bioprinting approaches will be reviewed, with a particular focus on how these techniques can be combined to mimic the multi-material hierarchical composition of living tissues. Key concepts underlying extrusion, laser and light-based technologies will be discussed, together with the recent emergence of field-based printing methods. Finally, technological advances and challenges towards the biofabrication of large, clinically-relevant multi-tissue constructs via the development of volumetric bioprinting will be discussed.

Biography

Dr. Levato's research focuses on the development of novel biofabrication strategies to create lab-made tissue models and transplantable engineered grafts, particularly for the regeneration of the musculoskeletal system. His lab integrates expertise in engineering, stem cell biology, biomaterials and cartilage and bone pathophysiology, to translate biofabricated structures towards novel treatments for the regeneration of damaged articulating joints. The application of said technologies for engineering soft tissues is also explored. For his work on biofabrication, he received several awards, including the 2018 Orthoregeneration Network Fellowship by the International Cartilage Repair Society, the 2016 Wake Forest Institute for Regenerative Medicine Young Investigator Award and the 2015 Julia Polak award by the European Society for Biomaterials. Prior to his appointment at UMCU, Dr. Levato also worked in several research groups in the field of Biomaterials: 3Bs, University of Minho, (Portugal); BioMatLab, Technical University of Milan (Italy), Institute for Bioengineering of Catalonia (Spain), and he holds a *cum laude* PhD in Biomedical Engineering from the Technical University of Catalonia (Spain). Currently he is mentoring 6 PhD students.

