Developing 3D microstructures for tissue engineering

casting process to generate various large scale tissue engineering constructs with single pore geometry with the desired mechanical stiffness and porosity. In addition, a new technique was developed to fabricate dual-pore scaffolds for various tissue-engineering applications where 3D printing of the PVA mould was combined with a salt leaching process. In this case, the sacrificial PVA mould, defining a structured network-architecture of micro-channels, was filled with salt crystals to define random porous regions between the structured regions of the scaffold. The compatibility of fabrication methods were tested with various biocompatible synthetic polymers such as polydimethylsiloxane (silicone), poly(-caprolactone) and poly(2-hydroxyethyl methacrylate), but other natural and synthetic materials can also be adopted to this process. The in-vitro biocompatibility of the fabricated scaffolds was successfully tested with HepG2 cells. To demonstrate the potential of scaffolds to release drugs and hereby control the behavior of cells growing on its surface, the silicone elastomer based perfusable capillary network scaffolds, generated from previous steps, was exposed to supercritical CO₂ in the presence of a hydrogel to create an additional interpenetrating network (IPN) of hydrogel nanodeposits. Biocompatible IPNs of silicone elastomer with poly(2-hydroxyethyl methacrylate) (pHEMA) and Poly(ethylene glycol) methylether acrylate (PEGMEA) hydrogel 3D scaffolds were produced in this way. The model drug doxycycline was loaded into the hydrogel of the IPN materials, and the biological activity of released doxycycline was tested using a doxycycline regulated green fluorescent reporter gene expression assay in HeLa cells. Additionally, decellularized liver extracellular matrix (ECM) and natural silk protein materials have been developed and tested for enhancing the differentiation of hiPSC-derived hepatocytes and fabricating biodegradable scaffolds for in-vivo tissue engineering applications.

Along with various scaffolds fabrication methods we finally presented an optimized study of hepatic differentiation of hiPSC-derived DE cells cultured for 25 days in a 3D perfusion bioreactor system with an array of 16 small-scale tissue-bioreactors with integrated dual-pore pore scaffolds and flow rates. Hepatic differentiation and functionality of hiPSC-derived hepatocytes were successfully assessed and compared against freshly obtained human precision-cut liver slices (hPCLS) as an ex vivo liver representative model as gold standard, developed by other project partners.

General information
State: Published
Organisations: Department of Micro- and Nanotechnology, BioLabChip, Bioanalytics, Fluidic Array Systems and Technology
Contributors: Mohanty, S., Wolff, A., Emnéus, J., Dufva, M.
Number of pages: 220
Publication date: 2016

Publication information
Publisher: DTU Nanotech
Original language: English
Electronic versions:
thesis_soumyaranjan_1_.pdf
Source: PublicationPreSubmission
Source-ID: 122159297