Exploring Tissue Viability and Tubule Formation of 3D Bio-Printed MDCK Cells and Canine Smooth Muscle Cells

Reshad, Ethan (School: Oviedo High School)

The growing demand for patient organs has revealed 3D bio-printing as a potential solution for the global organ shortage. However, a deeper fundamental understanding of vascularization is required to advance the application of 3D bio-printing. This research focuses on testing viability and tubule formation of MDCK (Madin Darby Canine Kidney) and canine SMC (smooth muscle cells) to achieve a vascularization method, peristalsis. A rhombus structure was chosen based on its simple geometry and its ability to measure peristalsis (waves/second). Three types of rhombus structures were printed. One with only MDCK cells, one with MDCK cells and SMC, and one with only SMC. Day 7 after printing revealed the tubule diameter of the MDCK group to be 130 microns. The replication rate of the different cell types allows us to predict the hierarchy of tubule diameter from greatest to largest: MDCK > Hybrid > SMC. The structure's cellular environment provides access to nutrients and space to replicate which is theorized to create an optimally constant viability rate. The use of a smaller syringe (25 microns) paired with a flow rate of 4 micrometers per hour and a translation speed of 0.1 millimeters per hour improved structure quality. This setting provided the structures with finer lines and sharper corners. The proven viability of the combined cell types provides insight into new combinations of cells that can be used to create future organs. Future efforts to trigger peristalsis require the involvement of a third cell type, Interstitial Cells of Cajal.

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