Cell Placement on 3D Matrices Using a Modified Ink Jet Printer

A. Chaubey[1], T. Boland[1], T.C. Burg[2], K.J.L. Burg[1]
1 – Bioengineering Department, Clemson University, Clemson, SC-29634
2 – Department of Electrical and Computer Engineering, Clemson, SC – 29634

Statement of Purpose: Microfabrication techniques have provided the basis for new tools to explore the interactions of anchorage-dependent cells with their *in vitro* environment. Constraining a cell population to a specific cell-surface contact area may dramatically affect cellular development [1]. Spatial control of the substrate chemistry and pattern can provide new insights into fundamental aspects of cell-surface interactions.

Several patterning techniques like microcontact printing [2] and laser-directed cell writing [3] have been applied toward this end. In contrast, we employed a modified ink-jet printer to print cells onto fibers for cell-surface interaction studies.

Methods: A melt flow indexer (Gottfert, Germay) was used to extrude PL (BI) fibers. The die used for extrusion had a 4 channeled configuration (4DG), which resulted in fibers as shown in Figure 1. Fibers were cut to the desired length (22 mm) and were subsequently taped onto glass microscope cover slips (22 sq.mm., Fisher). The entire construct was sterilized using ethylene oxide (Anderson). After sterilization the construct was soaked overnight in medium supplemented with fetal bovine serum to facilitate protein adsorption on the fiber. Bovine mammary epithelial cells (MAC-T, P22) transfected with green fluorescent protein (GFP) were used in this study. Cells were printed on the PL fiber by using patterns designed with word-processing software (Word , Microsoft) and printed using a modified HP Deskjet 340 series printer (Hewlett Packard) [4]. The print solution consisted of $1x10^6$ MAC-T cells/ml of medium and the pattern consisted of a straight line. The construct was aligned in such a way that the cells (print solution) were printed on the groove of the 4DG fiber. After printing, the cell-fiber construct was transferred to a 6 well-plate and kept in an incubator (37C, 5%CO_2) for 2 hours before adding culture medium.

Results/Discussion: Figure 1 shows a stereoscope image of the 4DG fiber. Figure 2 shows the cells printed on the polylactide fiber, after Day 1. As can be seen from the image, the cells were printed in a groove of the 4DG fiber in a single line, indicating the potential of the modified ink-jet printer as a device for cell patterning on 3D substrates.

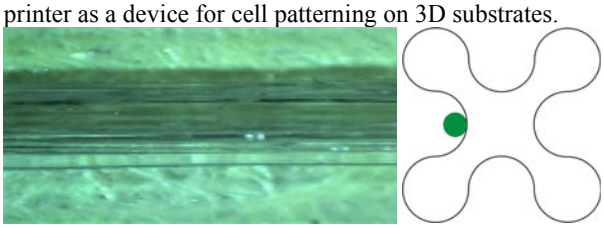

Figure 1. Stereoscope image of 4DG fiber and schematic of cross-section showing cell placement.

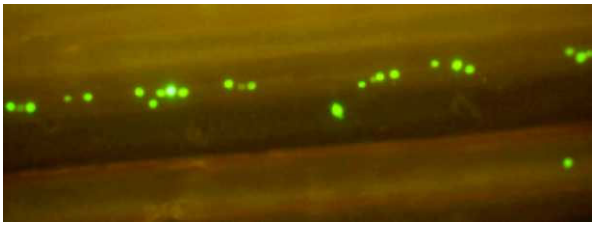

Figure 2. Printed cells on PL fiber; day 1, 100x.

Figure 3 shows the cells on the fiber on Day 16. The cells are still viable and have proliferated over the surface of the fiber. Xu and colleagues [4] reported 25% cell death after 72 hours of printing; our results show that the cell-death does not appear to compromise the development of the cellular fiber construct, even after 2 weeks in culture. Advantages of this printing method include low cost, application to wide range of substrates, high throughput, and suitability to 3D substrates.

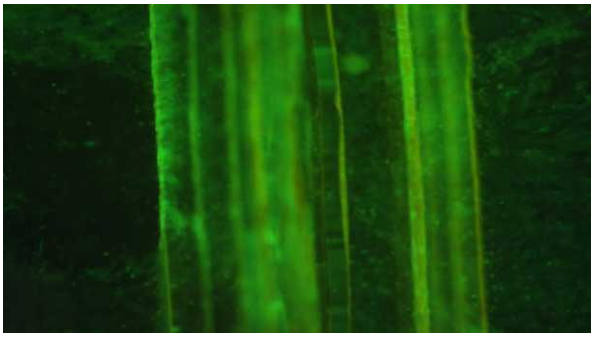

Figure 3. Printed cells on PL fiber; day 16, 100x.

Conclusions: In conclusion we have shown as a proof of concept that a modified ink-jet printer can be used to create viable cell-material constructs. This technology can also be used on any shaped scaffold and is inexpensive, fast, and provides a high throughput.

References:

1. Falconnet D, Csucs G, Grandin HM, Textor M. Biomaterials. 2006;27(16):3044-3063.
2. Singhvi R, Kumar A, Lopez GP, Stephanopoulos GN, Wang DI, Whitesides GM. Science. 1994;264:696–698.
3. Odde DJ, Renn MJ, Biotechnol Bioeng. 2000;67:312–318.
4. Xu T, Jin J, Gregory C, Hickman JJ, Boland T. Biomaterials. 2005;26(1):93-99.

Acknowledgements: This work was supported by a National Science Foundation PECASE (BES 0093805) and a Department of Defense Era of Hope Scholars Award.