Engineering Perfusable Renal Tubular Structures

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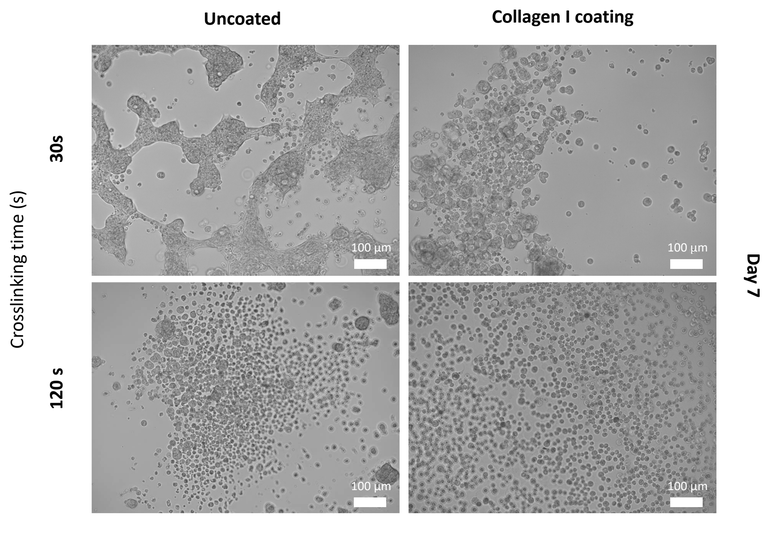
Introduction

The **kidneys** play a central role in homeostasis through filtration, reabsorption, and waste excretion. These processes are largely carried out in the **proximal tubule (PT)**, a highly convoluted structure whose three-dimensional geometry plays a critical role in regulating transport and cellular behavior [1]. However, most *in vitro* models rely on simplified geometries that poorly reflect this organization. **Advanced biofabrication approaches** provide new opportunities to recreate physiologically relevant and geometrically complex renal models [2].

Experimental Design and Validation

From Flat…

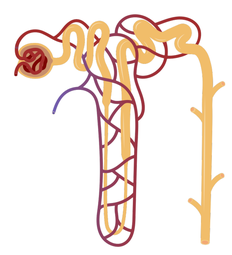
RPTECs adhesion and spreading on flat **GelMA** substrates



Softer hydrogels (**30 s crosslinking**) promote RPTEC adhesion

Collagen I coating does not enhance initial attachment.

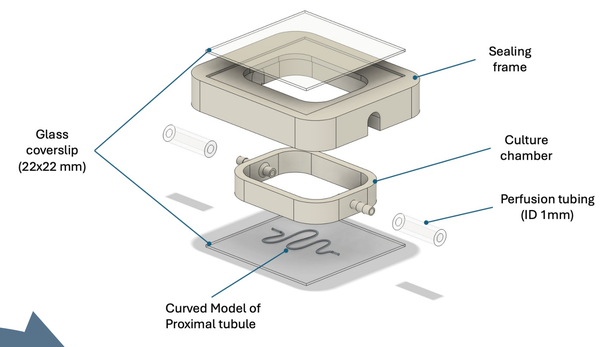
RPTEC:
Renal Proximal Tubule epithelial Cells
GelMA:
Gelatin Methacryloyl



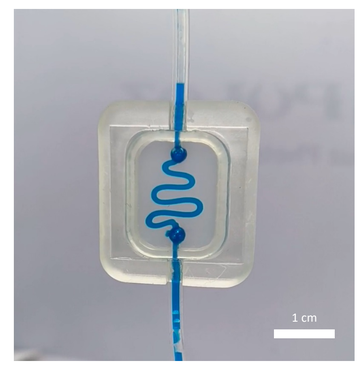
…To Volume!

To Curved…

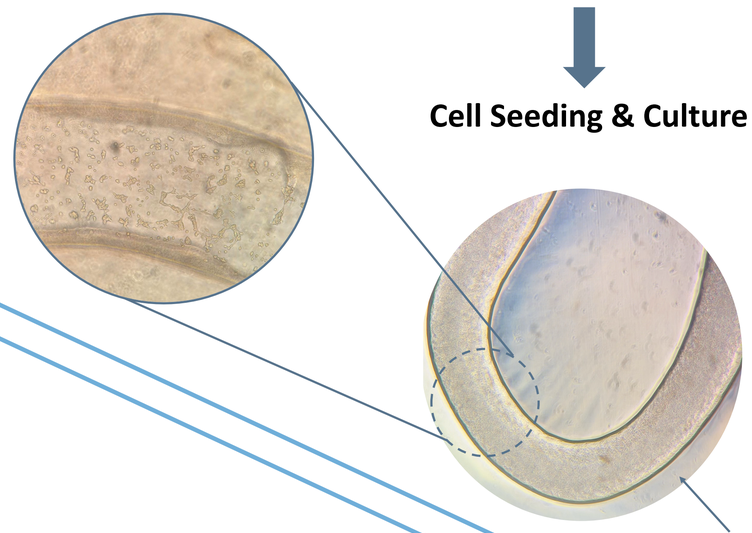
Chip Design & Layout



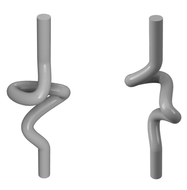
In-Chip Extrusion Bioprinting & Sacrificial Ink Removal

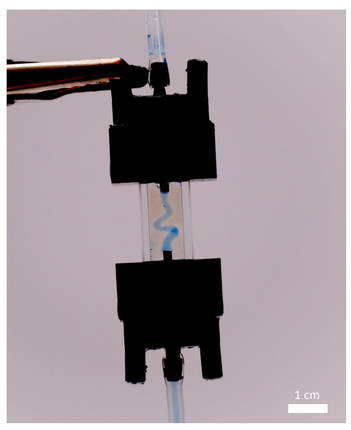


Cell Seeding & Culture



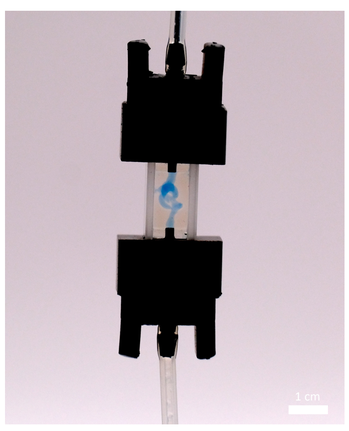
Controlled curvature geometry

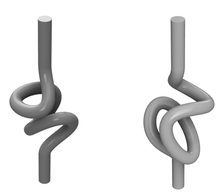




Volumetric bioprinting enables the fabrication of **complex**, fully 3D architectures beyond conventional layer-by-layer approaches.

Complex convoluted geometry





Conclusions

RPTEC adhesion is enhanced on softer GelMA substrates (30 s crosslinking), while collagen I coating does not improve initial attachment. Perfusable **microfluidic chips** with **3D channel geometries** were successfully developed and seeded with cells, representing a promising platform for the formation of tubular structures under static and dynamic culture conditions. Volumetric bioprinting further enables the fabrication of **highly convoluted architectures**, expanding the design space toward more physiologically relevant *in vitro* models.

References

1. Scott, R. P. et al. “The cell biology of renal filtration” in J Cell Biol, vol. 209 (2), April 2015, pp. 199-210.
2. K. Homan et al. "Bioprinting of 3D Convoluted Renal Proximal Tubules on Perfusable Chips" in Sci Rep, 2016, vol. 6, pp. 34845.

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let’s Connect!