Immunoprotection of Renal Epithelial Cells by Silicon Nanopore Membranes

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Background:
Immunoisolation of macroencapsulated renal cells is a fundamental requirement for an implantable bioartificial kidney that will circumvent the need for immunosuppressants. Silicon nanopore membranes (SNM) with precisely engineered pore dimensions have exhibited superior mass transfer and molecular selectivity characteristics for implanted hemofiltration. In this study, we investigated SNM competence for the protection of renal epithelial cells from an inflammatory cytokine known to induce necrosis and apoptosis.

Methods:
Four different types of renal epithelial cells (MDCK, HK2, LLC-PK1, and HPTCs) were grown to confluence on SNM with 7-nm wide slit pores. Transwell chambers were used as the control membranes. The cells were exposed to 500 ng/ml human tumor necrosis factor-α (TNFα) for 6 hours and the subsequent monolayer integrity was assessed via transepithelial electrical resistance (TEER), cell viability assay, and immunohistochemistry (IHC) techniques.

Results:
Without TNFα, cells on both Transwell and SNM maintained their monolayer integrity by expressing zona occludens (ZO1) protein at the intercellular junctions. TEER values were 100-150 ohm-cm2 and 580-620 ohm-cm2 on Transwell and SNM, respectively. For Transwells, TNFα disrupted epithelial tight junctions resulting in a decrease in TEER and 10 fold increase of cell apoptosis. In contrast, with SNM, cells maintained monolayer integrity with minimal changes in TEER and cell viability.

Conclusions:
SNM perform an immunoisolation function that can be adapted for the development of an implantable bioartificial kidney.