Electronic Supplementary Material (ESI) for Lab on a Chip.
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Open Multi-Organ Communication Device for Easy Interrogation of Tissue Slices

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1. **Supplemental Methods**

Shear Strain Calculations:

$$\tau = \frac{4\eta Q}{r^3\pi}$$

The above shear strain calculation was used to estimate the shear strain on a tissue slice in the device as flow was directed down through the culture well. The assumption was made that flow was flowing through an open cylindrical channel due to the cylindrical shape of the culture well. The diameter of the culture well is 1.2 cm and is 2 mm in height. To calculate shear strain, a flow rate of 40 μL/min, a viscosity of 1×10^{-3} Pa s, and a radius of 0.6 cm was used. The shear strain was calculated to be 3.9×10^{-5} $Dyne/cm^2$ which is not high enough to put undesirable stress on the tissue.

Chemicals

All chemicals used to prepare the following solutions were purchased from Fischer Scientific:
bicarbonate-buffer solution (130 nM NaCl, 2.5 mM KCl, 1.3 mM NaH_2PO_4, 26 mM $NaHCO_3$, 1 mM $MgCl_2$, 2 mM $CaCl_2$, and 10 mM glucose at pH = 7.4),
phosphate buffered saline (0.137 M NaCl, 2.7 mM KCL, 10 mM Na_2HPO_4, 1.8 mM KH_2PO_4 at pH = 7.4). All aqueous solutions were prepared using deionized water (Milli-Q, Millipore).

2. Supplemental Figures

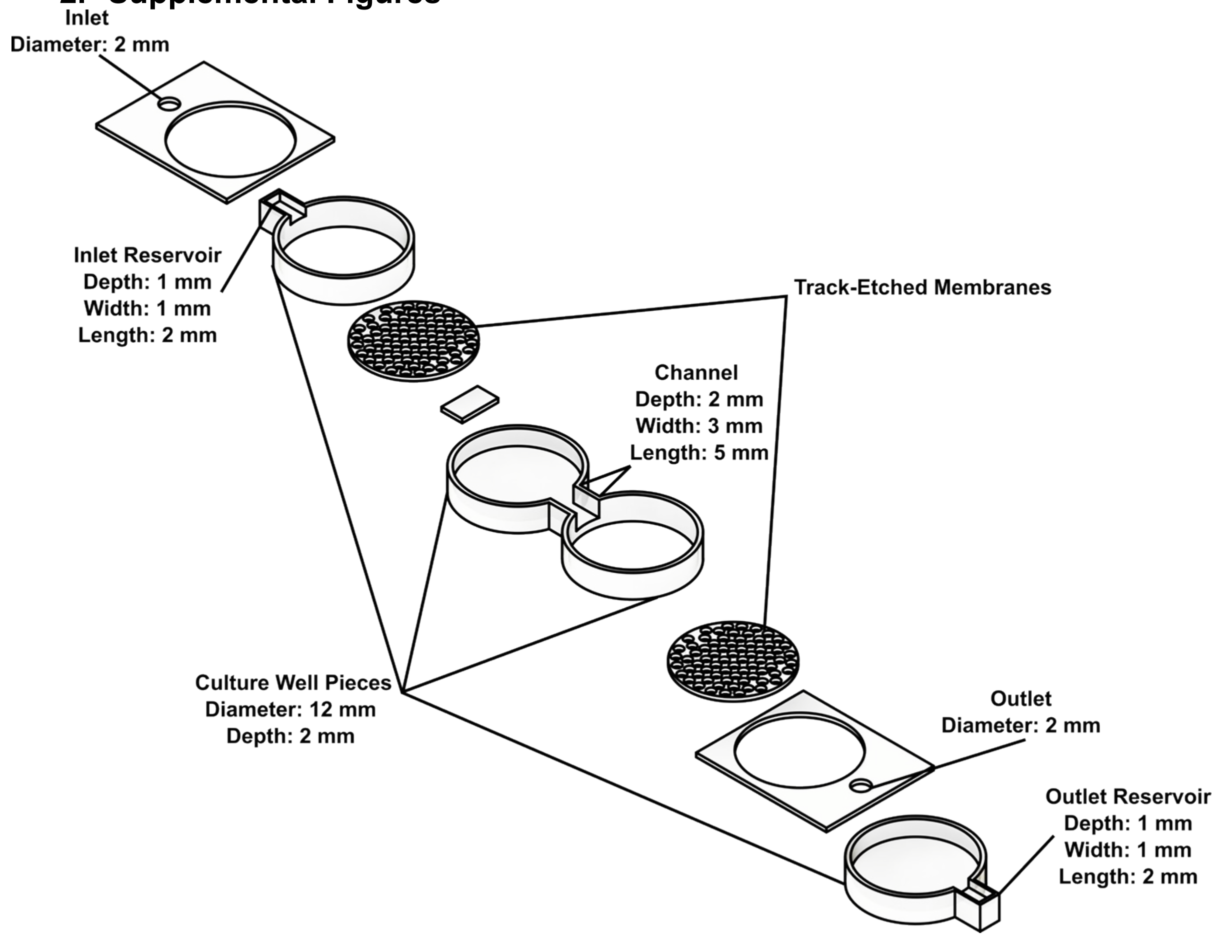


Figure S1 Exploded view of device in assembled order with dimensions

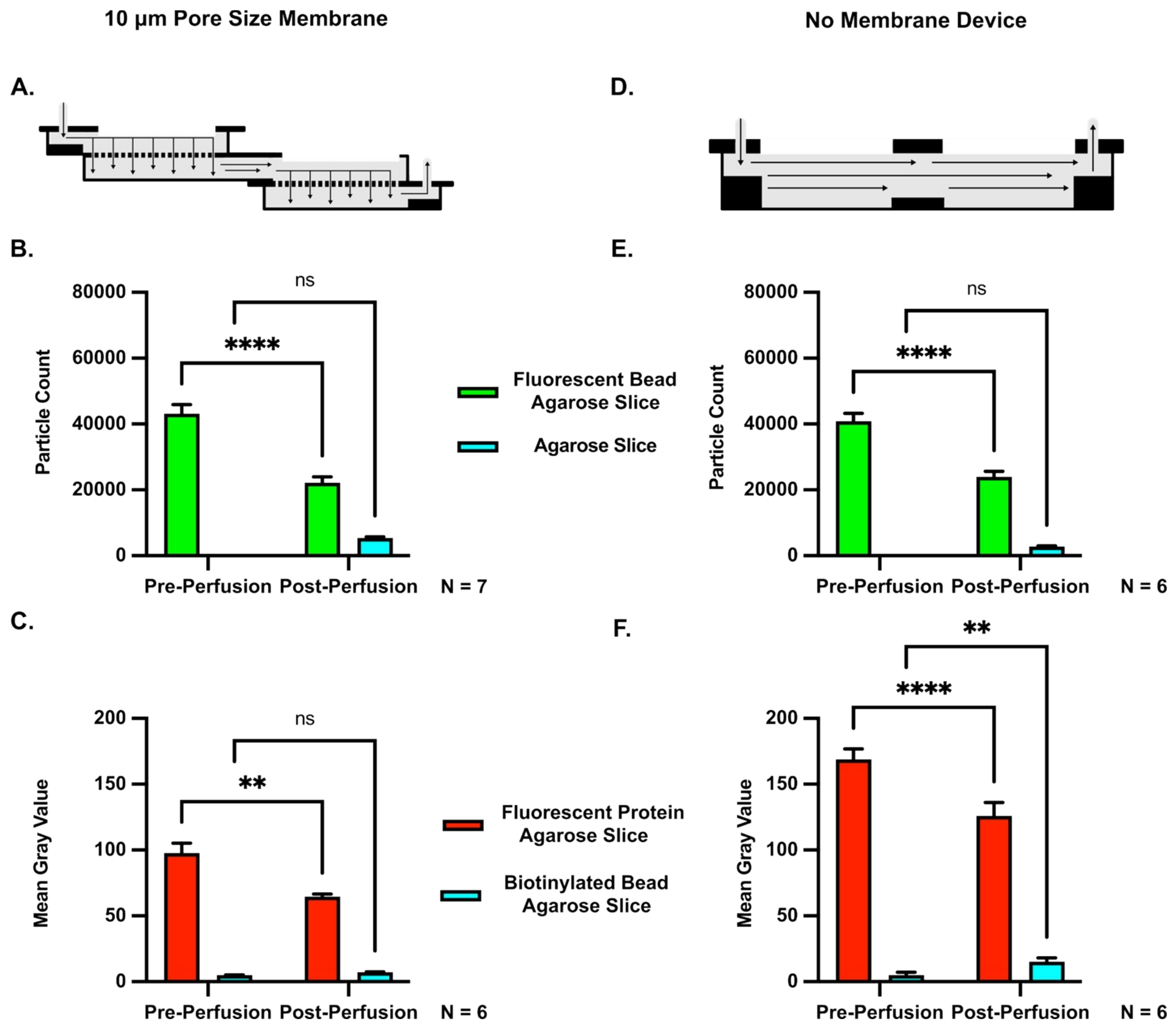


Figure S2 Differing chip configurations were analyzed to determine the best chip design. A) Chip design with a 10 µm pore size membrane. B) Fluorescently labeled particle movement on 10 µm pore size membrane chip. (n = 7) The particle movement to the agarose slice was determined to be non-significant (Two-Way ANOVA with Bonferroni post-tests, $p = 0.7376$). While the particle movement from the original slice was found to be significantly different (Two-Way ANOVA with Bonferroni post-tests, $p < 0.0001$) C) Fluorescent protein movement on 10 µm pore size membrane chip. (n=6) Protein movement from the protein slice was not found to be significantly different (Two-Way ANOVA with Bonferroni post-tests $p > 0.9999$). The fluorescent protein movement to the biotinylated bead slice was found to be significantly different (Two-Way ANOVA, Bonferroni post-tests ($p = 0.0012$). D) Chip design with no membrane E) Fluorescently labeled particle movement on no membrane chip (n=6). The loss of fluorescent protein from the embedded slice was found to be significantly different (Two-Way ANOVA with Bonferroni post-tests, $p < 0.0001$). The particle count in the agarose slice was found to be significantly different after perfusion (Two-Way ANOVA with Bonferroni post-tests, $p = 0.0088$) F) Fluorescent protein movement on no membrane chip. Protein movement from the embedded slice was found to be significant (Two-Way ANOVA, $p > 0.0001$) and the

movement into the agarose slice was found to be significant (Two-Way ANOVA, $p = 0.0088$)

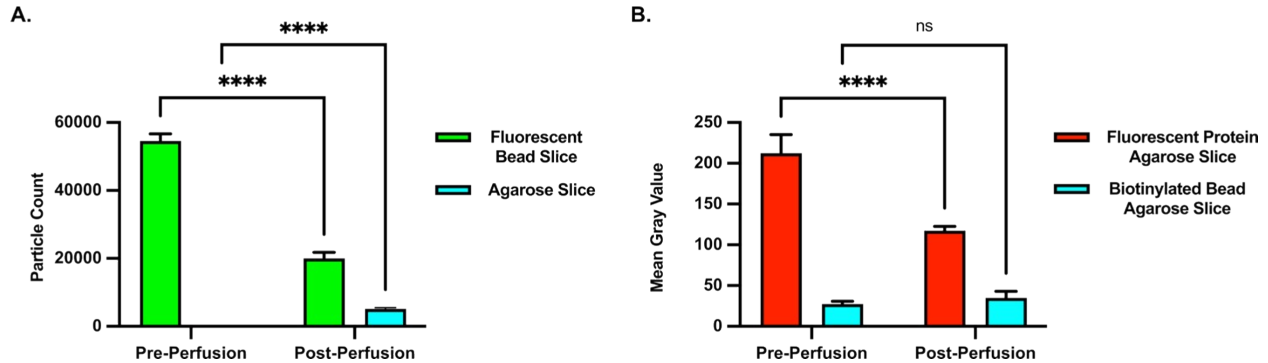


Figure S3 An overnight BSA coating restricted some movement of proteins, not beads, on-chip. A) Fluorescent bead movement from one agarose slice to another on-chip was still observed and was significant (Two-Way ANOVA with Bonferroni Post-Tests, $p < 0.0001$, $n = 6$). B) Fluorescent protein movement was significantly hindered on devices coated overnight (Two-Way ANOVA with Bonferroni Post-Tests, $n = 6$). Fluorescent protein left the fluorescent protein agarose slice (Two-Way ANOVA with Bonferroni Post-Tests, $n = 6$, $p < 0.0001$) but didn't make it to the biotinylated bead agarose slice (Two-Way ANOVA with Bonferroni Post-Tests, $n = 6$, $p > 0.9999$) indicating the overnight coating restricted protein movement.

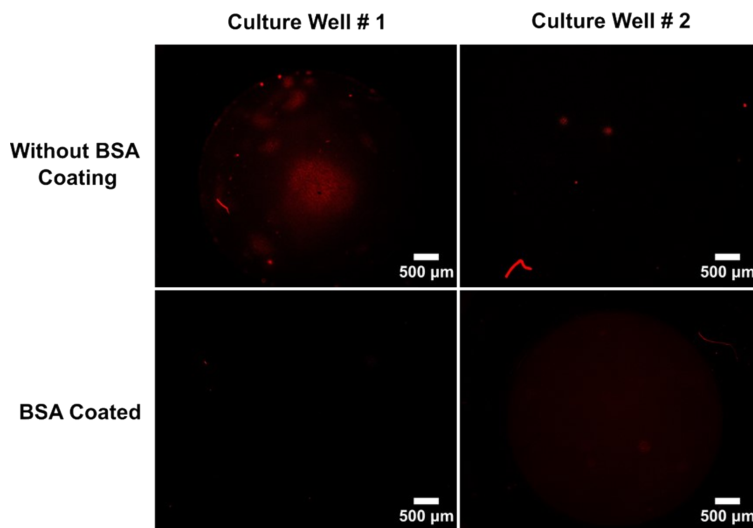
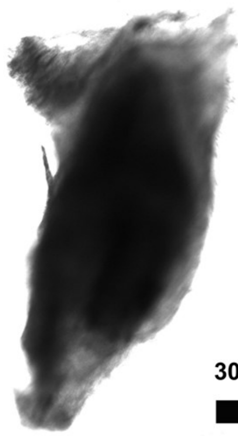


Figure S4 Residual protein was observed on track-etch membranes without BSA coating. To examine the residual protein left on the membrane, post-perfusion images were taken of the membrane with no agarose slices present. Images were taken from a device that was BSA coated and a device that was not BSA coated after 4 hours of perfusion with fluorescent protein slices. These images demonstrate the effectiveness of the 1 hour BSA coating.



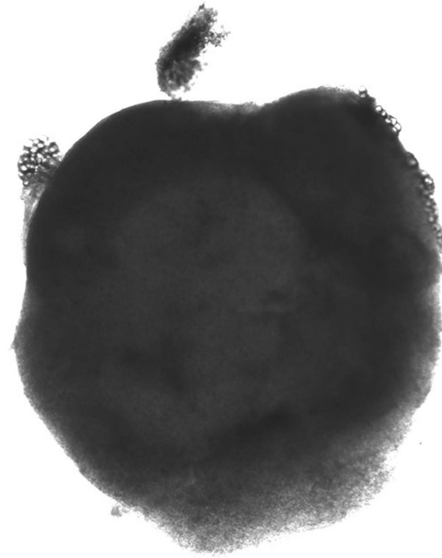


Figure S5: Example brightfield images of PP slices and MLN slices.