Department of Surgery
2026 Research Day
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Title:
Engineering Renal Structures with Organ-Specific DECM via TRACE Bioprinting

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Background:
The growing burden of kidney diseases highlights the need for physiologically relevant *in vitro* kidney models and functional grafts for transplantation. Existing kidney models often fail to replicate the native tissue architecture and complex vascular organization necessary for proper maturation and physiological function. Decellularized extracellular matrix (DECM) preserves organ-specific biochemical and biophysical cues, making it a promising biomaterial for bioink development in 3D bioprinting. Historically, DECM was challenging to bioprint due to slow gelation, resulting in limited structural fidelity post printing. In this study, we developed kidney-specific DECM (KDECM) bioinks and optimized their printability by adapting the TRACE (Tunable Rapid Assembly of Collagenous Elements) biofabrication strategy, enabling bioprinting of renal structures with complex tubular morphologies that better recapitulate nephron architecture and enhance biomimetic functionality.

Methods:
Porcine kidneys were decellularized, lyophilized, and dissolved in pepsin to form KDECM hydrogel. Following biochemical characterization, iPSC-derived kidney organoids were incorporated into KDECM to form a bioink. An optimized TRACE support bath enabled bioprinting of the bioink into complex tubular structures with preserved structural fidelity and cell viability

Results
KDECM hydrogel rapidly crosslinks in the macromolecular bath and showed excellent biocompatibility while maintaining iPSC pluripotency without undesired differentiation. Using TRACE bioprinting, we fabricated hollow tubular constructs with high structural fidelity that mimic native nephron tubules.

Conclusions (or Preliminary Conclusions):
Our goal is to fabricate nephron-like tubular structures that mimic the spatial organization and functional microanatomy of different kidney tubule segments. These findings demonstrate that KDECM combined with TRACE bioprinting enables the fabrication of functional tubules. This approach enables fabrication of optimal tissue constructs with potential applications in kidney disease modelling and as future transplantable grafts.