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On-Demand 3D-Printed Perfusion Chambers – A New Cost-Effective Option for Perfusion Cell Culture and Live Imaging

Introduction: Tissue engineering, which offers a promising pathway towards in vitro replication of 3D biological structures and hope for future biomedical innovations, is currently limited by challenges to the development of perfusable microvascular networks. Large tissue constructs require microvasculature to support their metabolic needs, but development of these constructs has been limited by the lack of variably-sized, reasonably-priced perfusion-capable tissue chambers. We have addressed this concern through the creation of a sterile glass and poly-dimethylsiloxane (PDMS) chamber, which is constructed using several custom-built 3D-printed molds. Our low-cost devices enable perfusion culture of collagen-based cellular scaffolds, as well as live-imaging of the tissues contained within.
Methods: 3D-modeling software (Fusion 360) was used to design molds and frames, which were printed on a 3D printer (Prusa i3 MK3S) in poly-lactic acid (PLA). Positive molds were filled with PDMS, which was cured to form chambers, as well as several other necessary perfusion circuit components including bubble traps, mason jar lid chambers, and media reservoir lid adapters.
Results: Two unique perfusion chambers were designed with different dimensions to accommodate separate experiments. Both devices were built for under 8 USD per construct and reused repeatedly. The constructs enabled both static and perfusion cell culture without contamination, and live imaging was demonstrated during static culture. During perfusion, the devices withstood flow rates that replicated arterial intra-luminal shear stresses (16 mL/minute through 16 gauge catheters) without leakage.
Conclusion: We have developed a low-cost tissue-engineering perfusion circuit using 3D-printing of custom molds. Our devices enable long-term tissue culture of large constructs with concurrent live-imaging. Our instructions are transferable, so that other labs may create and utilize our devices as well.

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