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Gelation of Uniform Interfacial Diffusant in Embedded 3D Printing

Stanford researchers developed a new technology that prints networks with distinct branch structures that emulate the natural branching observed in in vivo vascular networks.

Perfusion must be achieved when forming three-dimensional (3D) multicellular structures for tissue engineering, 3D in vitro models of organ development and disease, or fundamental studies of cell behavior, among others. The need for perfusion is exemplified through the vasculature in the body and the need for vascular-like structures in large 3D cell structures. While the process of angiogenesis is currently understood, the technology needed to fabricate components of a functional vascular network like multi-scale, branched structures (e.g., bifurcations and trifurcations) and the increasing and decreasing diameters of vessels naturally found in vivo, is lacking. Similar fabrication challenges apply to multiple tissues throughout the body, including lymphatics, airways, and the gastrointestinal tract.

Stanford researchers successfully fabricated perfusable tissue structures using a new strategy called Gelation of Uniform Interfacial Diffusant in Embedded 3D Printing (GUIDE-3DP), which overcomes some of the challenges above. Embedded 3D printing involves the fabrication of desired structures within a support material, reducing deformation due to gravity and enabling the printing of complex structures. The novel GUIDE-3DP method builds upon this approach by incorporating an interfacial diffusant strategy to rapidly fabricate perfusable networks of interconnected channels with precise control over the branching geometry and vessel diameters.

Stage of Development
Proof of concept

Applications

- Fabrication of in vitro 3D cell culture constructs, e.g drug screening platforms, or fluidic connections between existing lab-on-a-chip devices.
- Fabrication of implantable medical devices that require a branched, tubular structure such as vascular grafts or nerve guidance conduits, both of which are currently limited to simple cylindrical structures.
- Fabrication of other networks with distinct branch structures that emulate the natural branching observed in vascular networks in vivo.

Advantages

- This method enables the printing of complex networks with seamless junctions at branch points with user-defined geometry
- This method is compatible with existing photocrosslinkable bio-inks as well as novel bio-inks synthesized from recombinant proteins for cell-type customization.
- This method allows the printing of vessel structures with different, user-specified luminal diameters within the same network

Patents

- Published Application: 20230398803

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