MULTI-NOZZLE PRINTHEAD FOR CONSISTENT, RAPID IN-SITU DELIVERY OF BIOINKS WITH A HANDHELD BIOPRINTER

Supervisor: Dr. Axel Guenther, Co-Director, Centre for Research and Applications in Fluidic Technologies (CRAFT)

Contact Email: Sushant Singh (Ph.D. Candidate) sushant.singh@mail.utoronto.ca

Research Area: Bioprinting, 3D printing, fluid dynamics, bioengineering, translation technology

Project Description: Our lab excels in forming biomaterial-based structures using state-of-the-art microfluidic technologies. Our technologies allow for the precise positioning of cells and recapitulation of the structure of the tissue of interest. Specifically, we have developed a solution for the delivery of tissues, such as skin to treat burn wounds for example. Our platform technology consists of three components: (a) a handheld bioprinter instrument, (b) a cellular bioink, and (c) disposable parts for bioink delivery. We have previously demonstrated the only in situ bioprinting approach capable of covering wound areas at a rate >0.2 m^2/h or 10% of the total body surface area/hour (TBSA/h) owing to multi-nozzle microfluidic printheads and a patented handheld bioprinter[1,2]. Recently, we have developed a portfolio of new bioinks that outperform the bioinks investigated in our previous publications[2]. We intend on evaluating these bioinks with both the handheld bioprinter and other commercial 3D bioprinters.

In this project, we focus on optimizing the multi-nozzle printhead for the delivery of our new proprietary bioinks and for their integration into the handheld bioprinter. To optimize the print resolution, different measurement techniques will be utilized to analyze flow distribution within the printhead and print fidelity. The printheads will be fabricated in-house with thermoplastics to improve the shelf life and robustness of the printheads. All the research will be conducted in the brand new and state-of-the-art CRAFT Tissue and Microfluidic foundries[3].

Please contact us for any clarification. Students will be selected via an interview process.

Opportunities for students:

1. Gain research experience working in microfluidic and tissue foundries while learning from the senior graduate students of Guenther Lab.
2. Support research that will lead to publications, patents, and a potential startup company
3. Tackle challenges related to translating technologies from bench to industry

Useful resources:

1 Hakimi, N. *et al.* Handheld Skin Printer: In-Situ Formation of Planar Biomaterials and Tissues. *Lab Chip* **18**, 1440-1451 (2018).

2 Cheng, R. Y. *et al.* Handheld instrument for wound-conformal delivery of skin precursor sheets improves healing in full-thickness burns. *Biofabrication* **12**, 025002 (2020).

3 https://craftmicrofluidics.ca/about-craft