3D Bioprinter

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Problem Statement

For research of cancer and other diseases, it has become increasingly more important to have accurate 3D culture models that more closely mimic in vivo tissues and the surrounding extracellular matrix (ECM). The current and past two-dimensional (2D) cell culture models fail to provide a complex ECM environment that is necessary to understand the cellular reactions that occur in response to different drugs and therapeutics, while animal models are time consuming, expensive, and constantly fail to reflect human tumor biology. 3D bioprinting has recently emerged as a viable solution to this problem offering increased efficiency and reproducibility, however, these options are often too expensive ($10,000-200,000) for the average researcher to utilize. Manually producing these 3D culture models has proven to be a difficult and expensive task for many researchers, often resulting in high scaffold-to-scaffold variability.

Solution

We have begun developing a custom syringe-based extrusion system that can be retrofitted to most commercial 3D printers to provide a reliable, inexpensive, and efficient platform for manufacturing cell-embedded 3D ECM environments with enhanced accuracy and reproducibility. This system will reduce cell product variability through the creation of statistically similar cellular microarrays with 3D printer precision allowing researchers to perform studies with increased sample sizes and more repeatable results.

Results

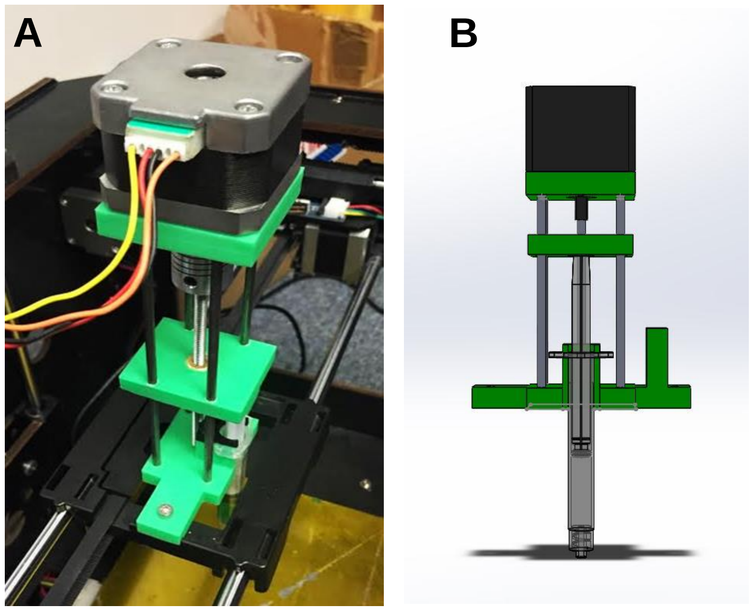

Figure 1: A) Overhead view of assembled extrusion system retrofitted to Wanhu Duplicator & B) CAD model of assembled extrusion system
*Parts in green 3D printed using PLA filament

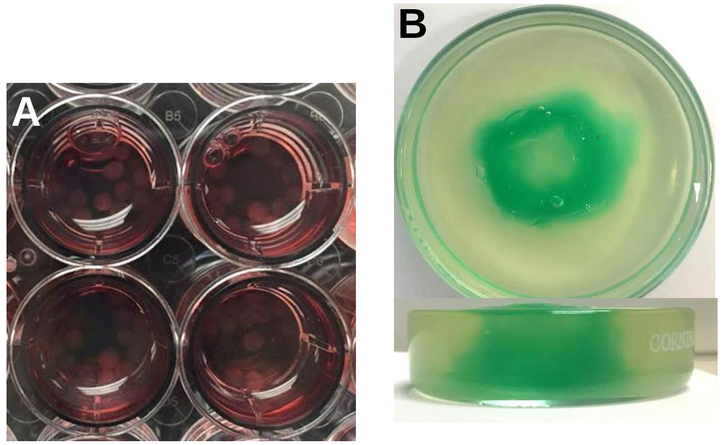

Figure 2: A) Cell-containing alginate beads in wells filled with media; B) 3D printed alginate (green) hydrogel printed into petri dish of gelatin support bath for precision test

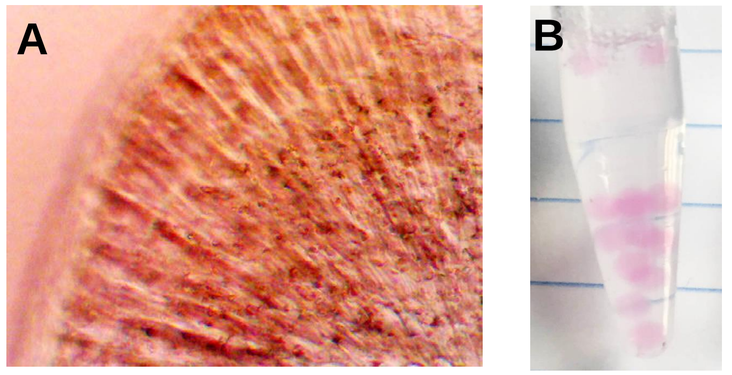

Figure 3: A) Microscope image of cell-seeded alginate bead at day 2 B) Eppendorf tube of cell-laden beads on day 2 before centrifugation and addition of sodium citrate

Conclusions

- Customized thread-driven syringe-based extrusion system with an open frame and user-friendly design
- Allows for easy access to syringe for replacement
- Minimal moving parts to prevent mechanical failure
- Lightweight to minimize stepper motor error
- Can easily be retrofitted to other common 3D printers
- Cost effective, just under $35 to produce

Future Goals

With further research and funding this system can lead to potential applications in reducing the barrier-to-entry for the advanced bio-manufacturing field and streamlining the therapeutic approval process in hopes of bringing personalized medicine into the field of therapeutics.

Goals for Future Iterations:

- Make printer head design more compact
- Design universal retrofitting unit compatible with more printers
- Fabricate enclosure for sterile environment
- Increase efficiency of printing process & optimize reproducibility/complexity of printed structures
- Create customized BioInk to achieve more accurate culture conditions

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Space Coast FABLAB

NORTHROP GRUMMAN

Engineering & Science Student Design Showcase at Florida Institute of Technology