Bioprinting Module Design

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INTRODUCTION

Proteins are the most common molecules found in cells and are vital to all life. To date, scientists identified over thousand proteins that are secreted by human cells.[1] This secretome is necessary for our tissues, organs, and body to function properly. As a starting point of creating artificial organs, in this work, we have developed a functional inkjet printing system, designed to print protein solutions to any solid surface.

METHOD

In recent years, there have been significant interest in the use of inkjet printing with applications in biology, chemistry and medicine.

Inkjet printing is a non-contact printing technique to precisely position of picoliter to nanoliter droplets to create a pattern. So far, three types of drop-on-demand inkjet printing method were identified to manipulate the ink drops: thermal, piezoelectric and magnetic. Instead of piezoelectric and magnetic inkjet printing, thermal inkjet printing method was used in this work due to reported cell lysis and cell membrane damages in the piezoelectric and magnetic manipulation methods.[2]

Thermal inkjet printers employ tiny resistors to create heat. Increased temperature inside the ink chamber vaporizes ink to create a bubble. As the bubble expands, some of the ink inside the reservoir is pushed out of the nozzle. The size of the ink droplet can be controlled by temperature gradient, frequency of current pulse, pulse width, and ink viscosity.

In this work, our aim is to design an adaptable inkjet bioprinter module. The module consists of the main controller, cartridge controller, inkjet cartridge and mechanical apparatus for the assembly.

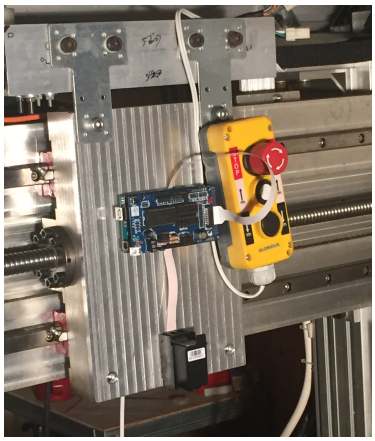

Figure 1. Bioprinting Module Prototype

RESULTS

The main objective of this study was to design and test a biocompatible printing system to fabricate cell supporting structures and protein arrays.

Bioink was prepared per the following directions: Cartridge was cleaned and sterilized with ethanol-deionized water solution. Bovine serum albumin (BSA) (Merck Albumin Fraction V - Bovine Serum Albumin) was dissolved in pH 7.4 phosphate-buffered saline (PBS) solution at 1 mg/ml.[3] Cleaned and rinsed cartridge then filled with homogeneously dissolved bovine serum albumin bioink.

The functionality of developed bioprinting system was tested to ensure stable nozzle manipulation, droplet positioning, continuous printing and pattern creation (Figure 2). Protein printing results were observed by inspecting the glass slide onto which proteins were printed. (Figure 3)

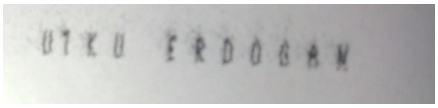

Figure 2. Droplet Positioning and Nozzle Manipulation Test Results

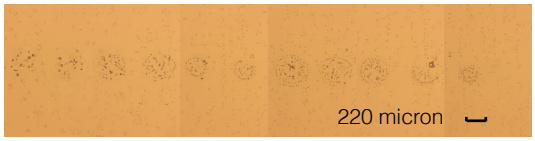

Figure 3. Droplet Size and Protein Concentration

Developed bioprinter using the inkjet technology and its feasibility was shown in this study. Although the bioprinting system was tested with protein solution, it has a capability to print hydrogels, living cells, growth factors and nutrients.

REFERENCES

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