3D Printing of Scaffolds for Cardiovascular Tissue

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INTRODUCTION

- Heart disease leading cause of death in the U.S, with about 650,000 fatalities reported by the CDC in 2019
- Myocardial infarction caused by oxygen deprivation to the heart muscles leads to damage of the heart cells
- 3D printed scaffolds using biocompatible materials can serve as a matrix for seeding cardiovascular cells
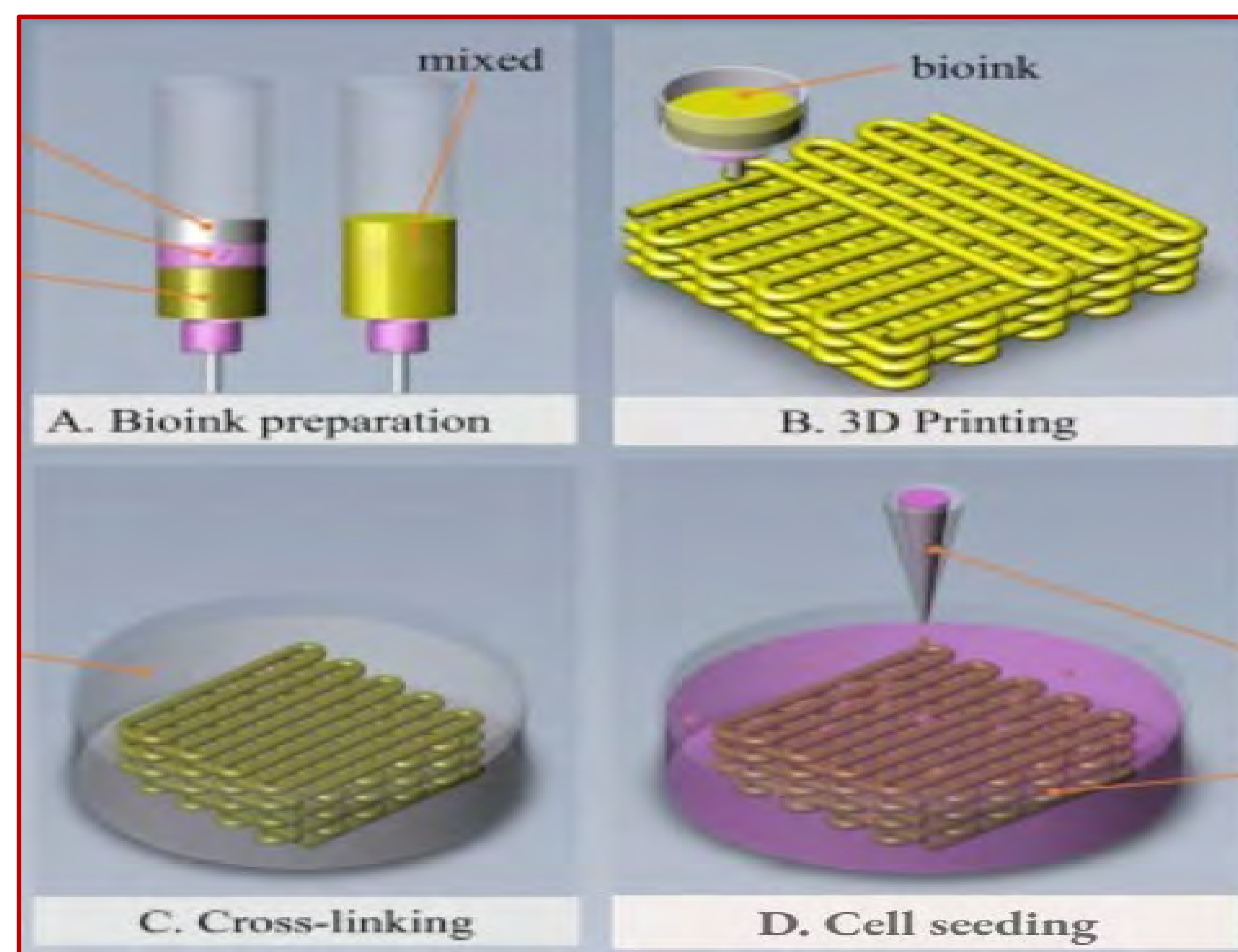
OBJECTIVES

Fig 1. Summary of project

A. Bioink preparation
B. 3D Printing
C. Cross-linking
D. Cell seeding

Goal

Design low-cost 3D printed scaffold using biocompatible materials, determine optimal scaffold criteria, and printing parameters

METHODS & MATERIALS

Tissue Scribe Printer
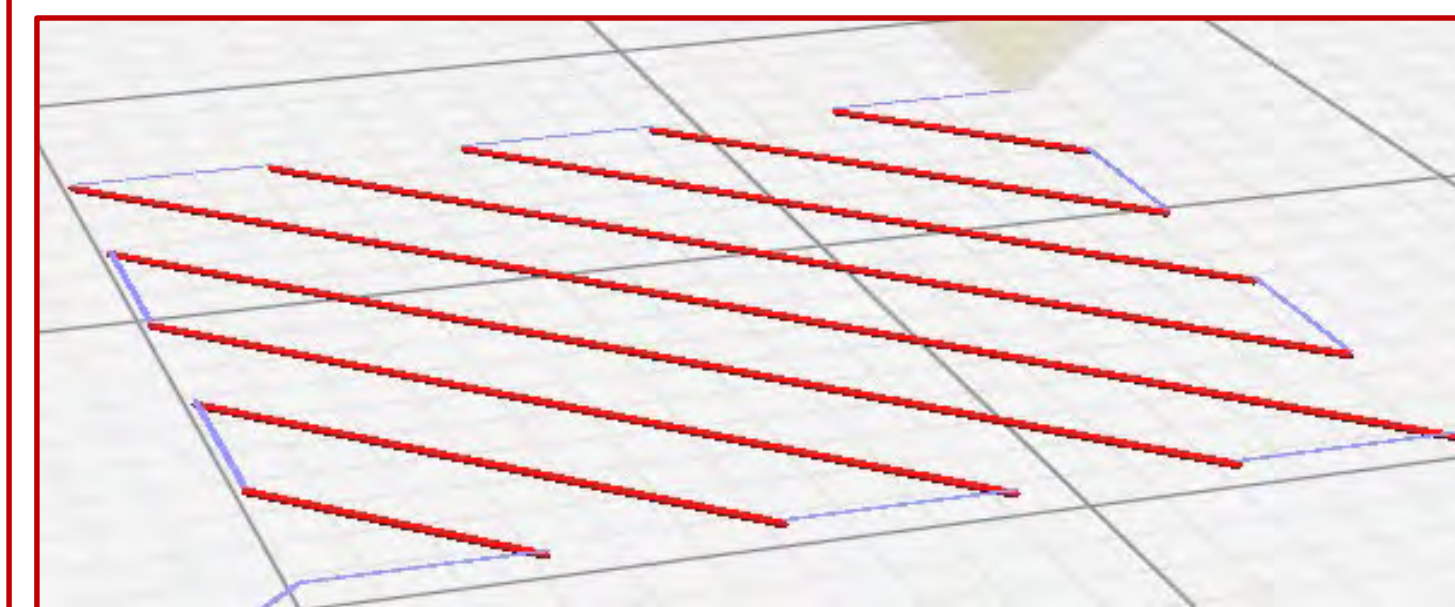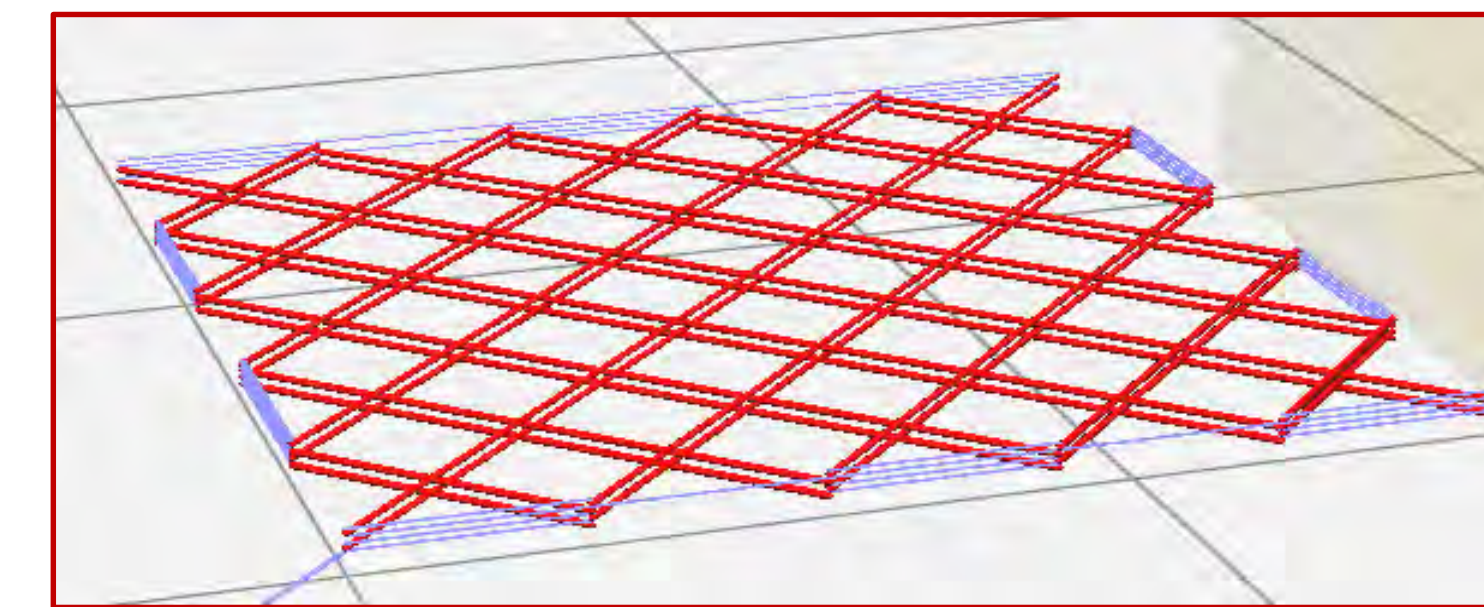

Proposed Scaffold Design

Fig 2. 1 layer seen in Cura

Fig 3. 4 layers seen in Cura

Biomaterials

Porcine Gelatin 5 wt% crosslinked with 1,4-Butanediol diglycidyl ether (BDDGE)

Cross-linker

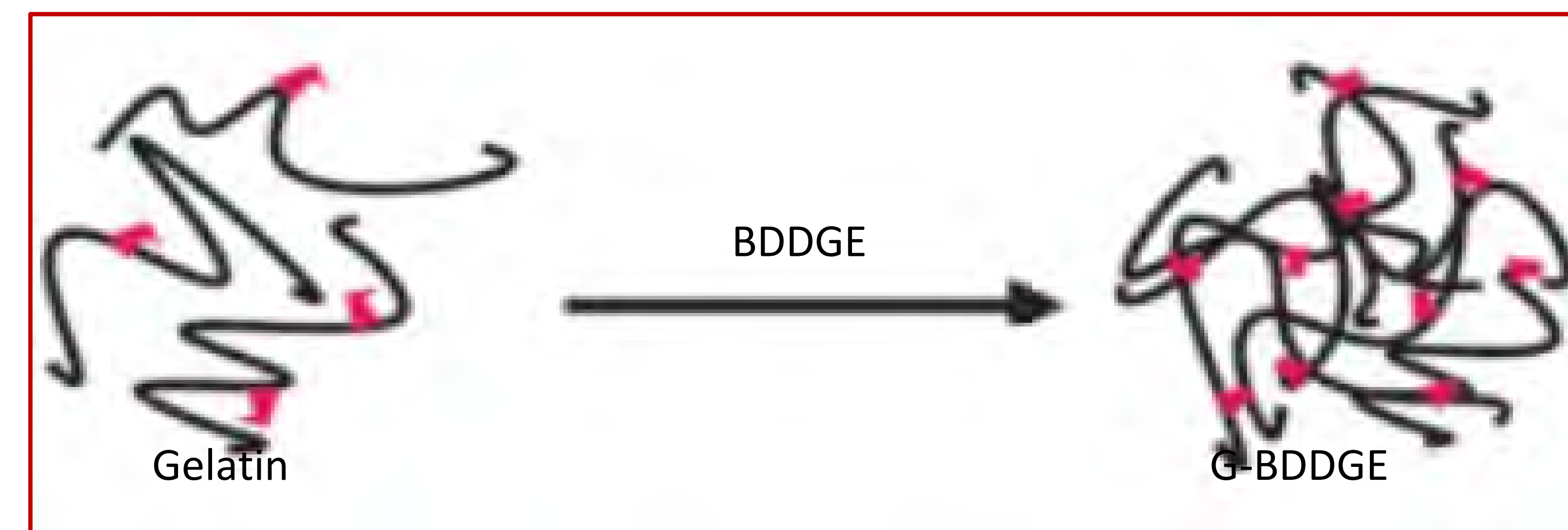

Gelatin   BDDGE   G-BDDGE

Fig 4. Mixture of Gelatin and BDDGE forms a solid structure in 48 hours

RESULTS

Scaffold Criteria

- 5 layers for total 15mm X 15mm
- 3mm distance between lines having 5 lines per layer.
- Initial height of first layer at 150 μm with increments of 30 μm for the next 4 layers
- An extrusion rate of 2.5μm/mm

Preliminary Scaffold Results

35 mm

Fig 5. 1 layer with blobs

35 mm

Fig 6. 1 layer without blobs

35 mm

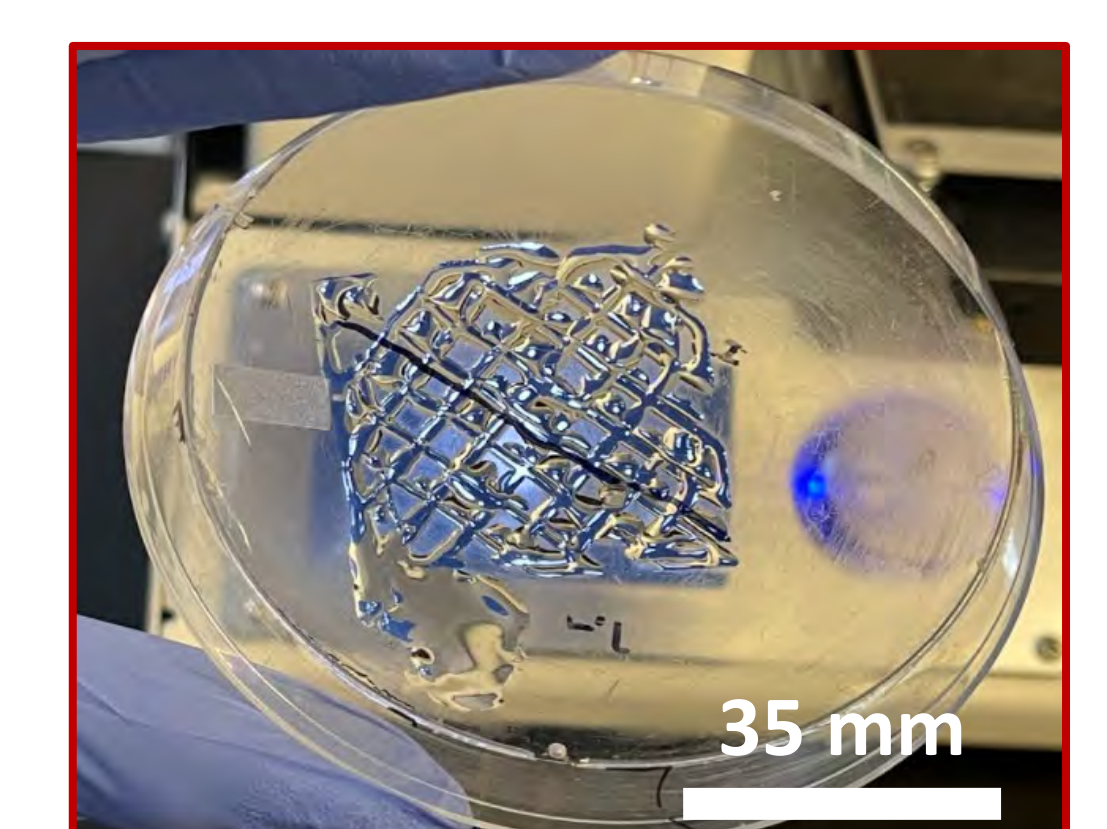Fig 7. 1 layer of size 35 mm

35 mm

Fig 8. 2 layers of size 35 mm

15 mm

Fig 9. 1 layer of size 15 mm

15 mm

Fig 10. 5 layers of size 15 mm

SUMMARY & FUTURE WORK

- **Status to date:** printed 5 layers of the scaffold and determined optimal criteria and parameters
- **Challenges**: creating a more dynamic G-code generator, avoiding the formation of blobs when stacking layers, working around the unpredictability of material behavior, and optimizing the storage temperature of hydrogel while printing.
- **Future work**: print defined lines, crosslink the gelatin with BDDGE and perform testing at physiologically relevant temperatures