

Introduction

An estimated 1.3 million Canadians are living with heart disease¹, which can lead to heart attacks.

A heart attack, or myocardial infarct, produces an irreversible loss of cardiac muscle cells (cardiomyocytes).

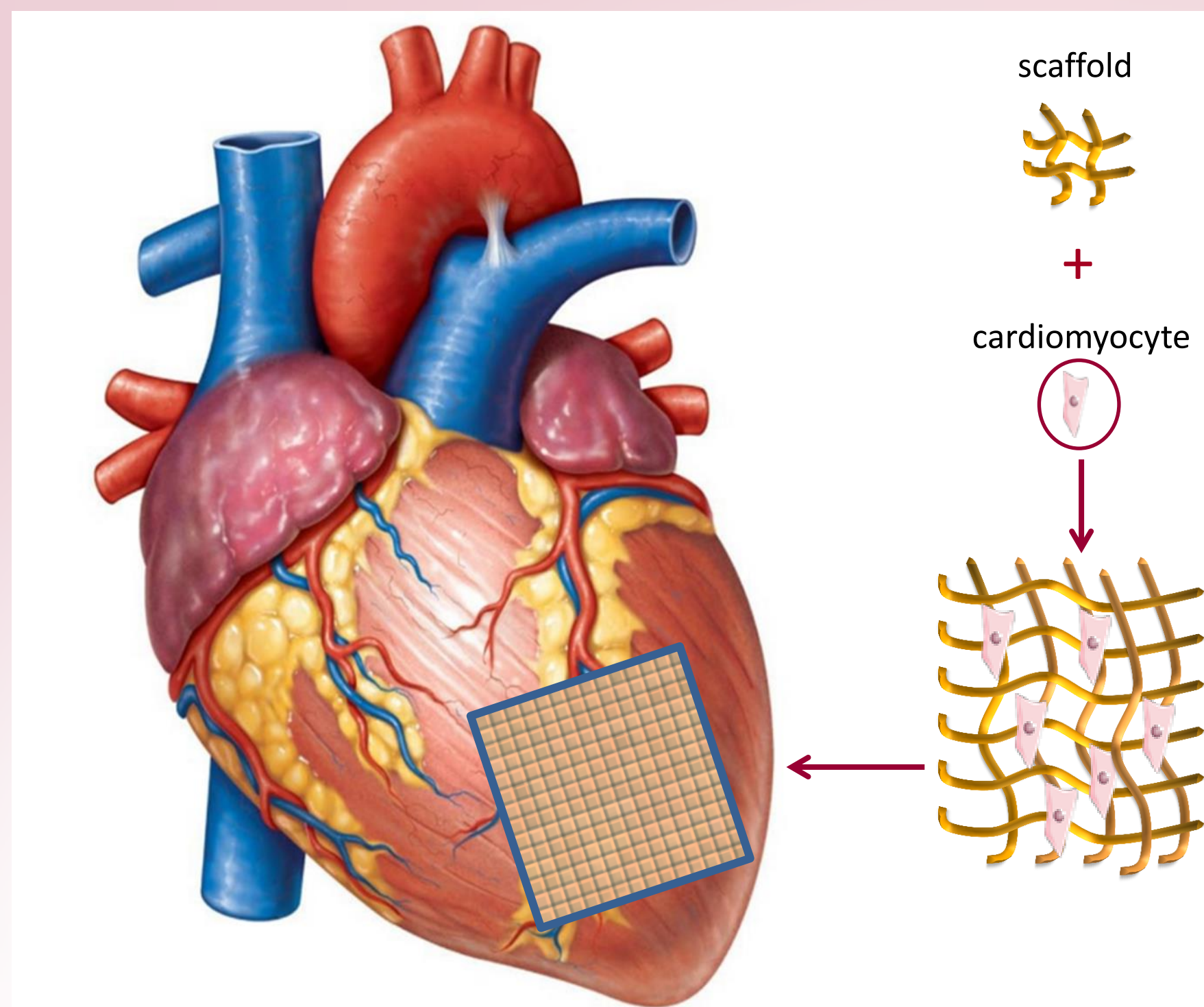


Figure 1. Human heart with cardiac patch (modified image²).

This results in a non-conductive surface that disrupts the normal electrical flow within the heart, so the heart cannot function properly. Several remedial therapies have been proposed, including creating a patch made of a biocompatible and electroconductive material to cover the non-functional area of the heart. This patch would promote cell infiltration and tissue regeneration.

Collagen-based materials are being considered for the patch, but their limited conductivity hinders their use in the regeneration of electroconductive tissues. To overcome this limitation, the material's electroconductivity can be improved by incorporating metal nanoparticles.

This project aims to produce for the first time collagen fibres with silver nanoparticles (AgNP) embedded in the collagen helix, which will serve as templates for the proliferation of cardiomyocytes.

Methodology

The hybrid collagen fibres were produced by electro-spinning collagen solutions containing varying amounts of silver nanoparticles.

A flow pump was used to drip the collagen-AgNP solution onto a spinning rotor in the presence of an electrical field. Two rotors were used:

- small diameter rotor, 2000 rpm, 15.0 kV
- large diameter rotor, 500 rpm, 15.0 kV

The fibres were removed from the rotors either on aluminum foil, or by using glass slides.

An SEM microscope was used to analyze and take pictures of the fibres.

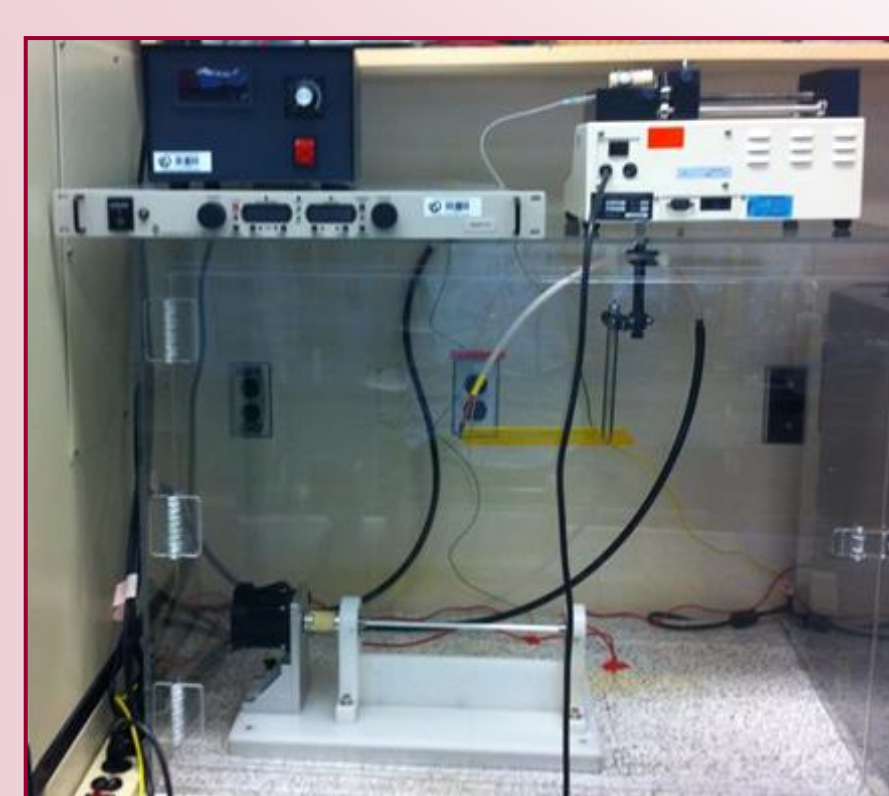
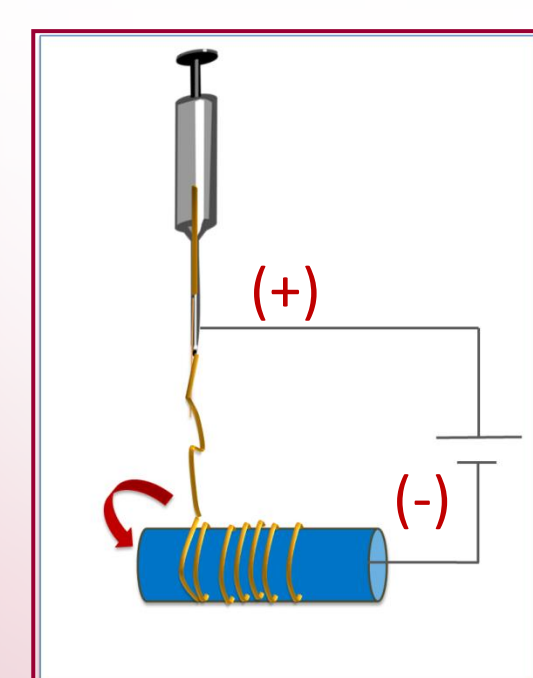


Figure 2. Electro-spinning equipment set-up.

Results

The hybrid collagen fibres with embedded silver nanoparticles were formed successfully, and appear stable.

The goal was to obtain the thinnest and most stable fibres possible, as these are the most suitable for a cardiac patch. The solution that contained a 1:1 ratio of collagen to silver nanoparticles generated the best fibres.



Figure 3. Large diameter rotor covered in hybrid collagen fibres.

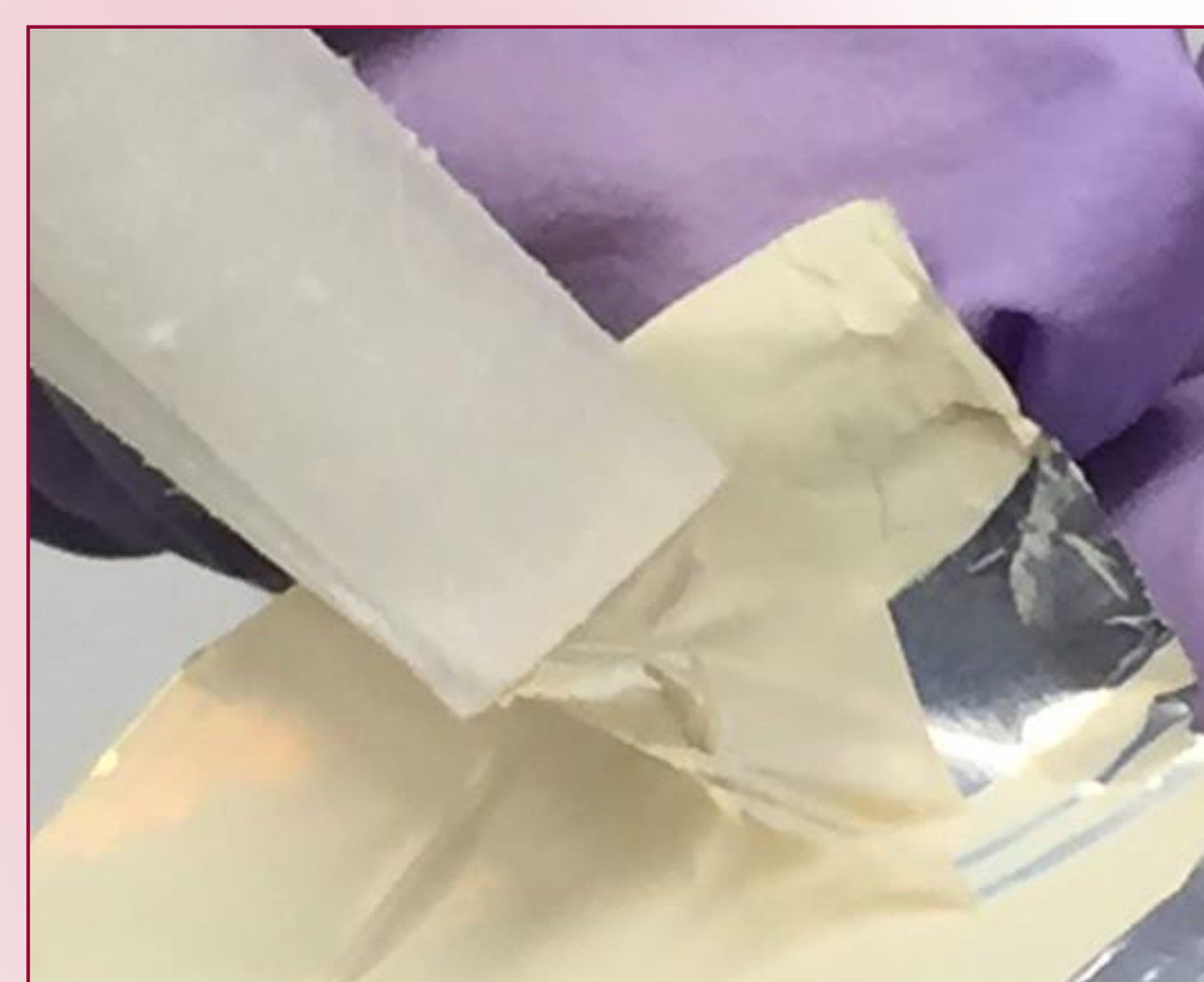


Figure 4. Hybrid collagen fibres collected on aluminum foil.

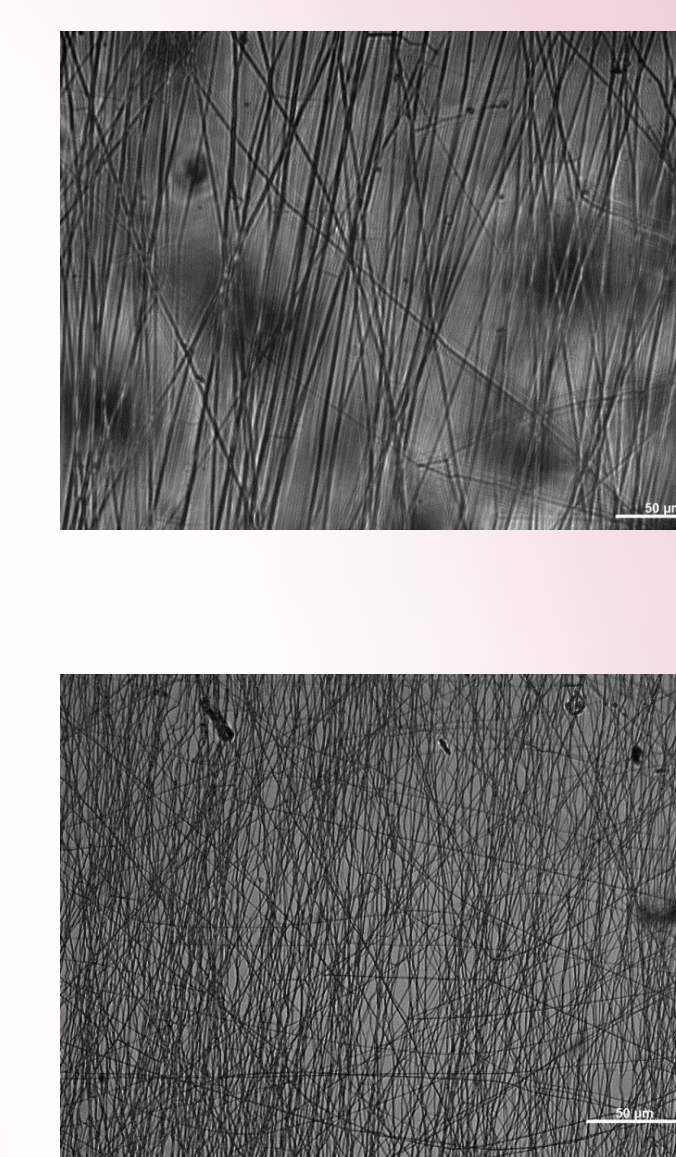


Figure 5. Magnified images of the fibres.

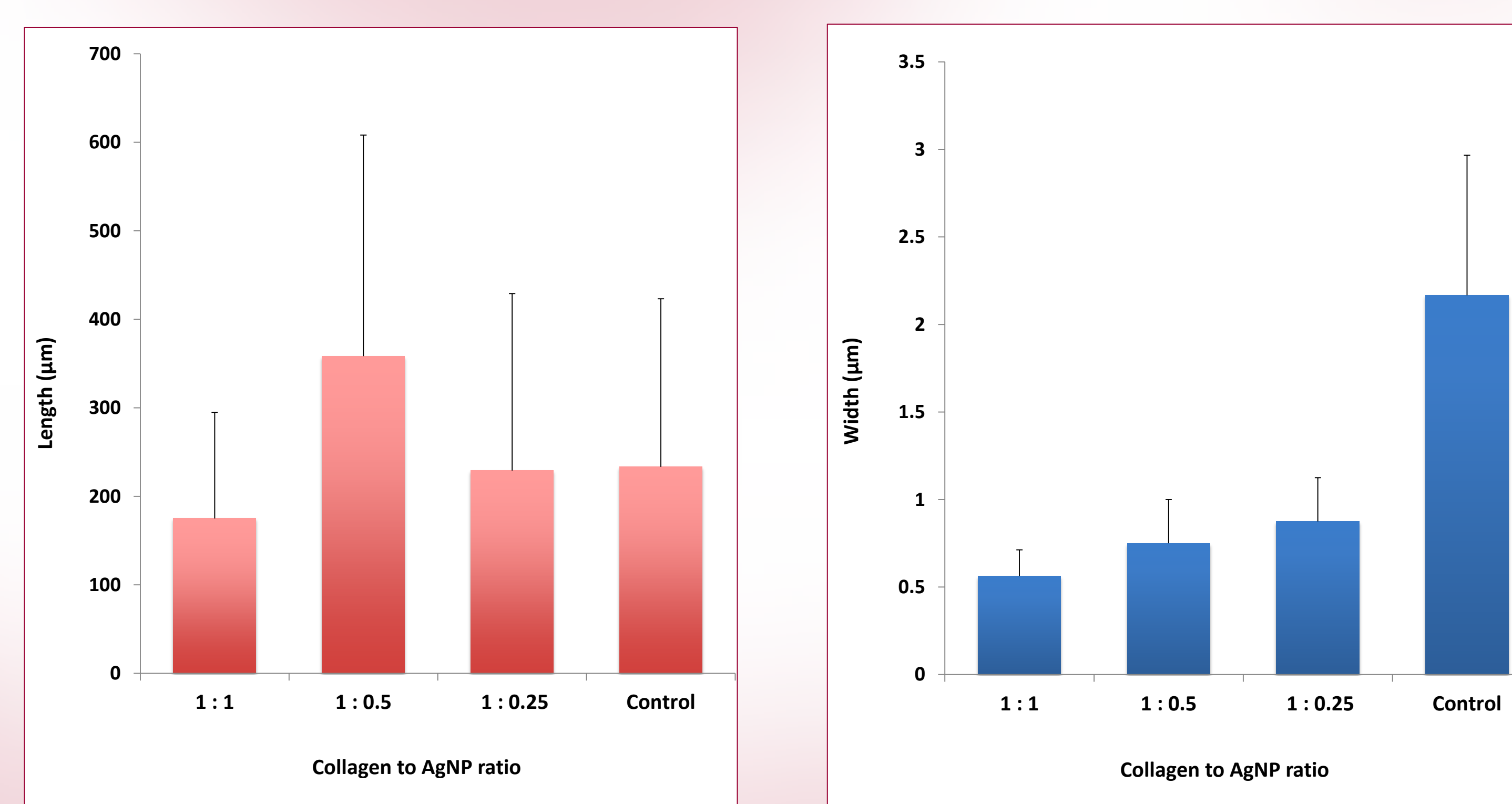


Figure 6. These graphs represent the length and width of the hybrid collagen fibres produced using varying ratios of collagen to silver nanoparticles. **The solution that contained a 1:1 ratio of collagen to silver nanoparticles generated the shortest and thinnest fibres.**

Conclusions

The results support the hypothesis that a hybrid collagen-based material can be made with silver nanoparticles embedded in the collagen helix.

The material's stability and properties, such as biocompatibility and electroconductivity, suggest that this material can serve as a template for the cell proliferation of cardiomyocytes.

This work could pave the way to the successful fabrication of a cardiac patch with electroconductive and regenerative properties.

Future studies

The next steps are to further optimize the material, test its resistance to enzymatic degradation, and perform *in vitro* tests. The proliferative capacity of the fibres will be evaluated on neonatal mice cardiomyocytes. The material's ability to sustain cell viability will also be assessed.

References

- [1] Heart and Stroke Foundation. (2015). Statistics. Recovered from <http://heartandstroke.com/site/c.iklQLcMWJtE/b.3483991/k.34A8/Statistics.htm>
- [2] Pearson Education Inc. (2010). Human Heart. Recovered from <https://www.thinglink.com/scene/715516620675481600>

Acknowledgements

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