PhD Open Days

Novel Cardiac Tissue Engineering (CTE) Approaches: exploring the anti-inflammatory benefits of natural acorn phenolic compounds in electrically stimulated bioprinted constructs

PhD in Biomedical Engineering

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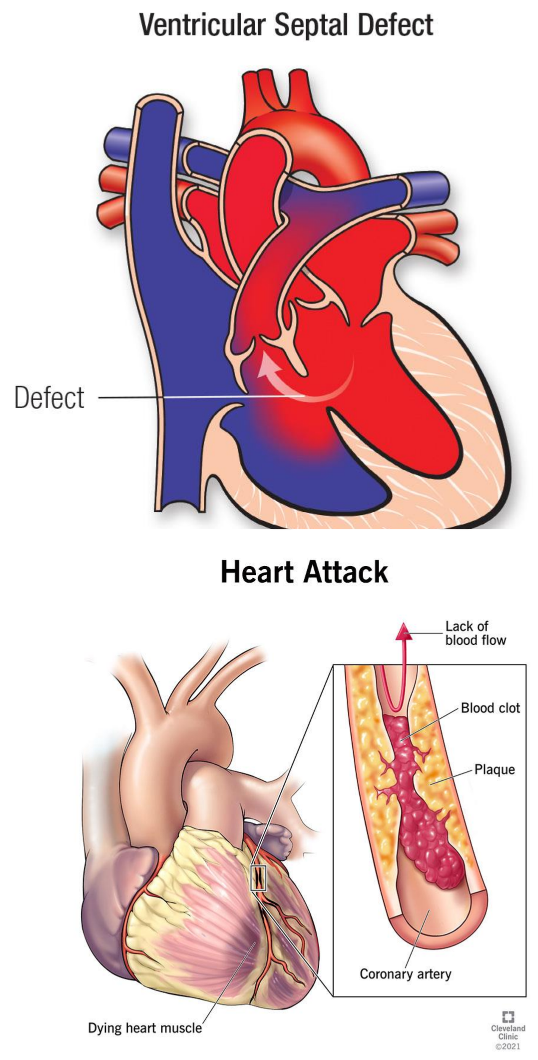
MOTIVATION

- Congenital heart defects occur in 1% of births. Myocardial infarction affects 4% of the population <60 years old and 10% of the population >65 years old.
- Specified cases may be solved with therapeutic tools of regenerative medicine.
- Bioprinting can provide a solution for the needed devices, with the printing of cardiac tissue.
- Addition of biofactors in the bioprinted constructs can improve healing through anti-inflammatory agents.
- Portuguese industry can identify natural compounds from acorn by-products with interest for the biomedical field.

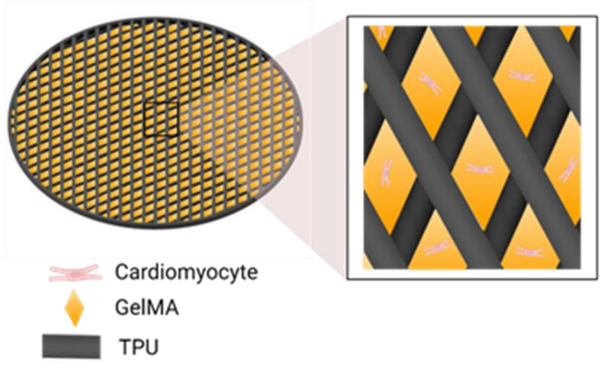


AIM

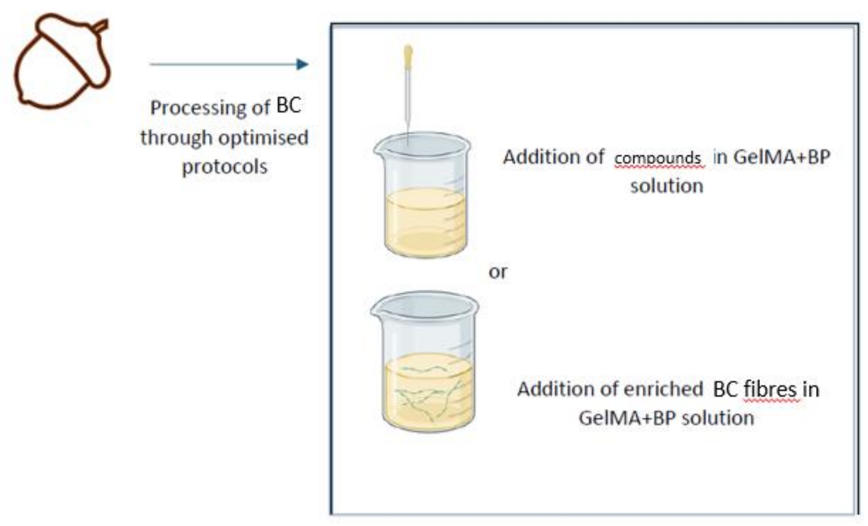
- Obtain a conductive patch to help cardiac function.
- Deliver a bioactive material to manage inflammation.
- Foster circular economy through the use of industrial by-products.

METHODOLOGY

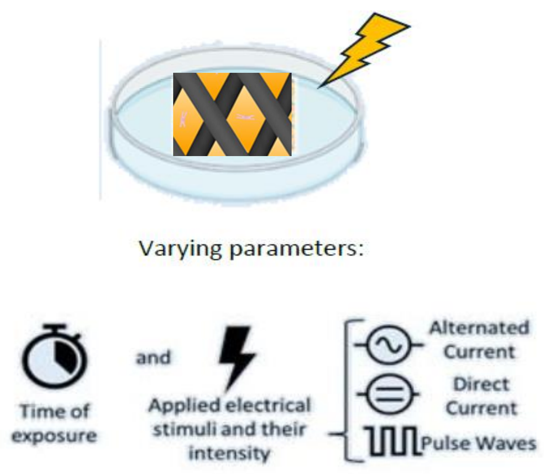
1. 3-D printed synthetic polymer mesh structure with encapsulated human induced pluripotent stem cells-derived cardiomyocytes (hiPSC-CMs).



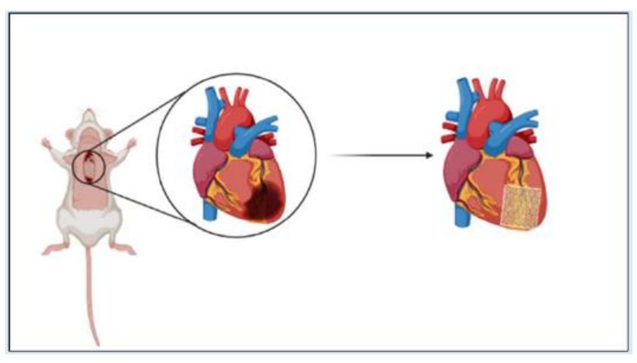
2. Addition of bioactive compounds (BC) in GelMA doped with electrically conductive particles.



3. Investigation of correlation of different electrical stimulation regimes in hiPSCs differentiation/maturation of CMs, and BC release rate.



4. *In vivo* studies of the cardiac patch, and regulatory path for clinical translation assessment.



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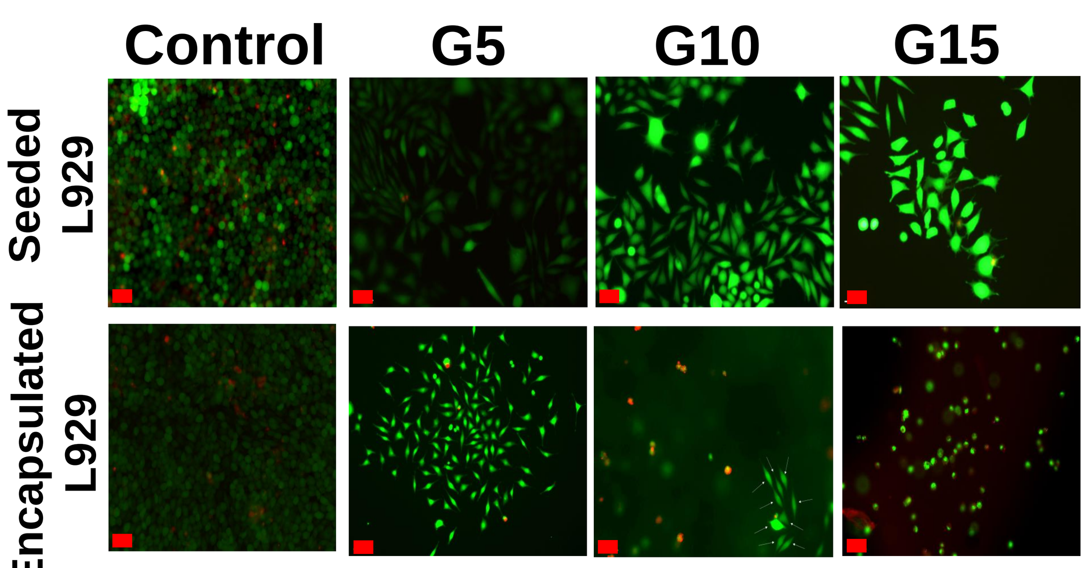
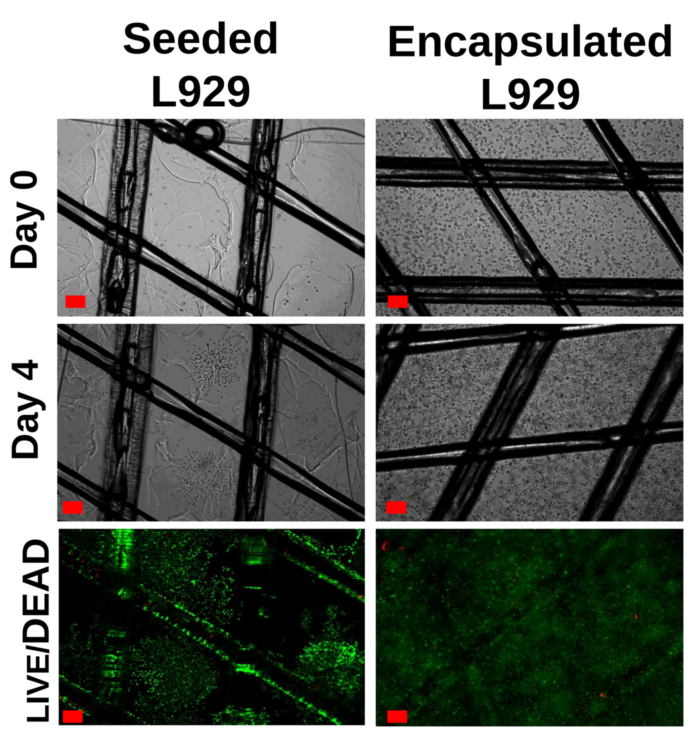
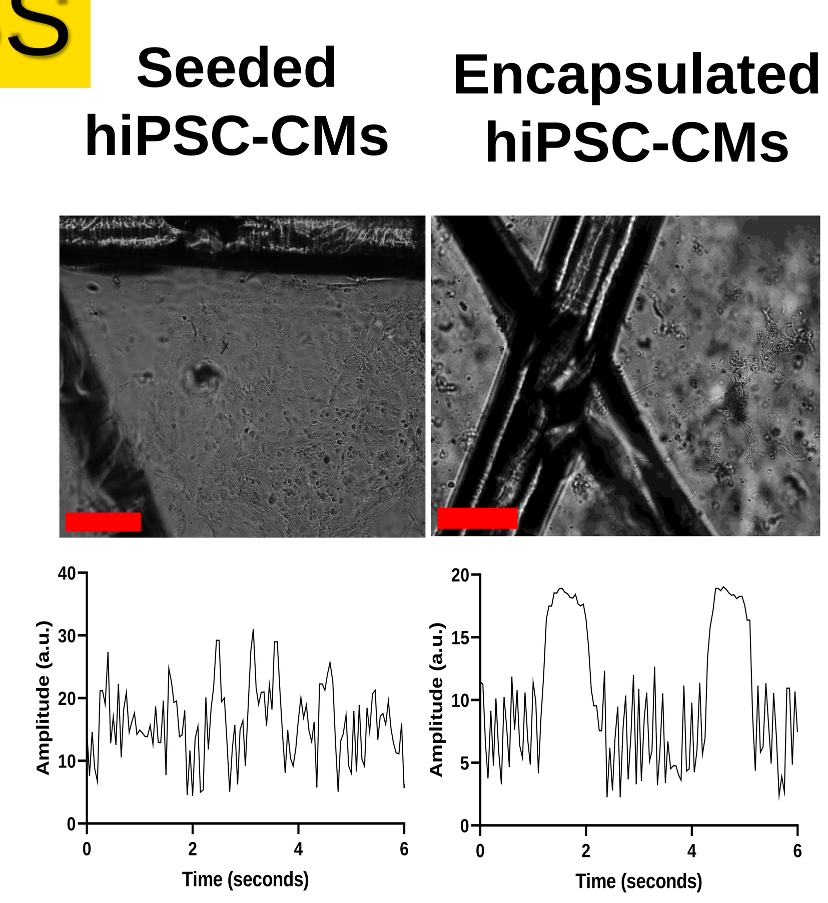


High biocompatibility of GelMA was observed after 10 days, with cell viability above 80% (Scale bar 100µm).





Integration of materials was achieved. Seeded and encapsulated L929 showed good viability (Scale bar 50µm). Cardiomyocytes maintained viability and beating (Scale bar 250µm).

CONCLUSIONS

- Blending of natural materials and synthetic polymers resulted in migration, spreading and formation of hiPSC-CMs clusters.
- The results demonstrate a proof of concept, allowing for the further testing with electrical cues in the materials.

Supervisors: Prof. Frederico Ferreira, Prof. Jorge Morgado, Dr. Raphaël Canadas

TÉCNICO LISBOA

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