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Engineering functional cardiac tissue using a twist-expand mechanical bioreactor

Stanford researchers have invented a twist-expand mechanical bioreactor that provides an appropriate *in vitro* microenvironment for induced pluripotent stem cell (iPSC) derived cardiomyocytes to achieve biomimetic anisotropic alignment and form contractile cardiac tissue.

Many studies have successfully demonstrated directed differentiation of iPSCs into cardiomyocytes. However, further assembling and maturing the iPSC-derived cardiomyocytes to mimic the mechanics of the native heart tissue remains a challenge. To overcome this challenge, studies have created microenvironments resembling that of primary cardiomyocytes during development: micropillar structures were placed to provide a 3D environment and exogenous cues were applied to facilitate anisotropic alignment of cells for coordinated contraction and electrical conduction. The engineered tissue's maturation was improved but still not comparable to the native heart.

Researchers at Stanford have devised a platform that provides a more biomimetic microenvironment (Figure 1). Using advanced 3D bioprinting technology, cells were printed with soft silicone in preferred arrangements. The print was placed in an electrically conductive bioreactor that can be actuated to apply torsional force or pneumatic pressure to the silicone to introduce twisting and contractile cardiac mechanics that the micropillar approach neglected to include. This system has the potential to form functional macro-level heart tissues from iPSC-derived cardiomyocytes.

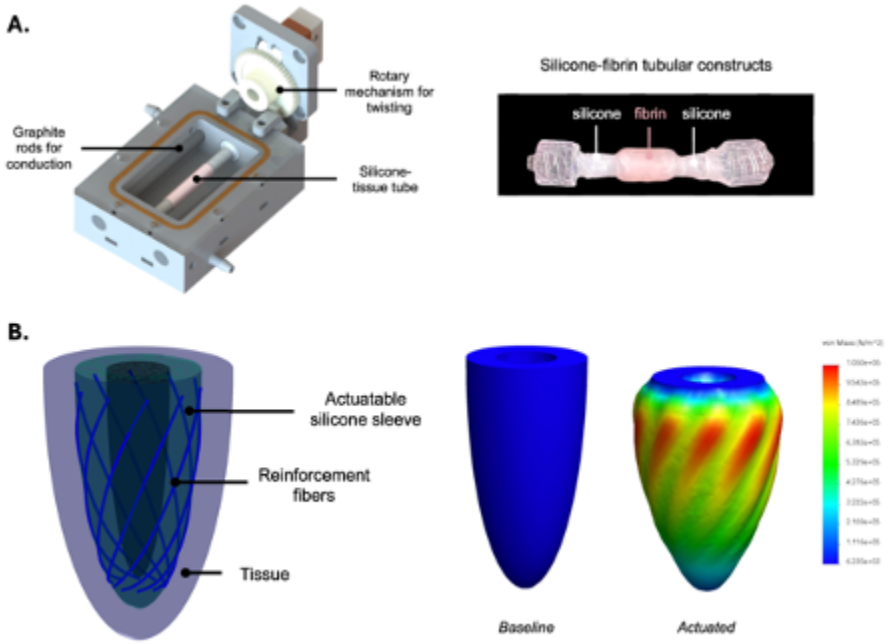


Figure 1. A) Silicone-tissue tube. B) Ventricular-shaped silicone-tissue sleeve.

Stage of Development
Prototype

Applications

- Cardiac tissue engineering
- Drug testing
- Disease modeling
- Developmental studies

Advantages

- Mimics the complex contractile pattern of the native heart tissue better than other existing systems
- Potential for personalized treatment

Patents

- Published Application: WO2025159990

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