Autopilot Single-jet 3D Electrospinning Enables Anatomically Conformal and Functional iPSC-derived Cardiac Patches

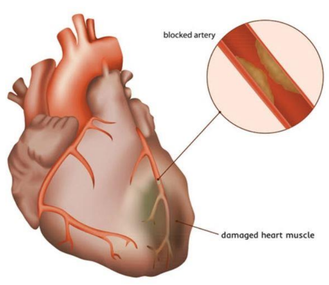
Balchandar Navaneethan[1], Sandra Varghese[1], Chia-Fu Chou[1,2*]

[1]Institute of Physics, Academia Sinica, Taipei, Taiwan

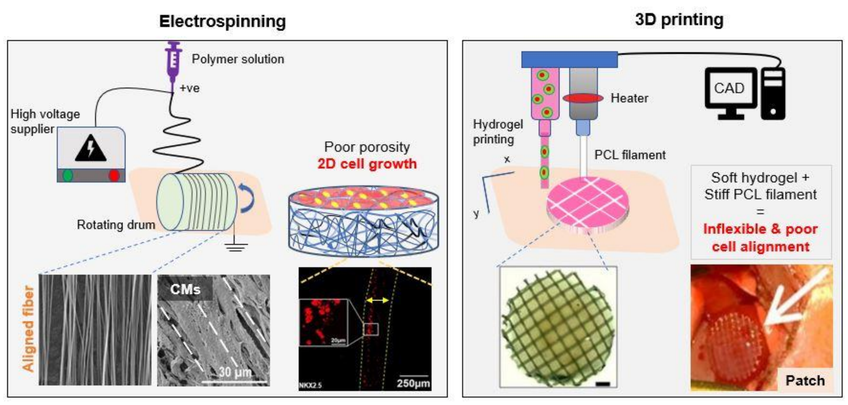
[2]Research Center for Applied Sciences, Academia Sinica, Taipei, Taiwan

State-of-the-art of Cardiac Patches:

➢ Designing challenges

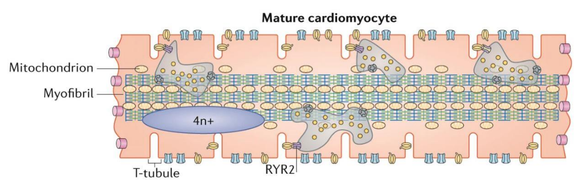


Myocardial Infarction



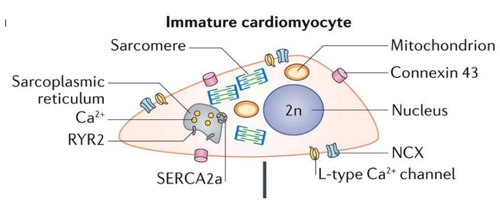
- *Poor structural and architectural mimicry*

➢ Biological challenges



- *Absence of true 3D environment*

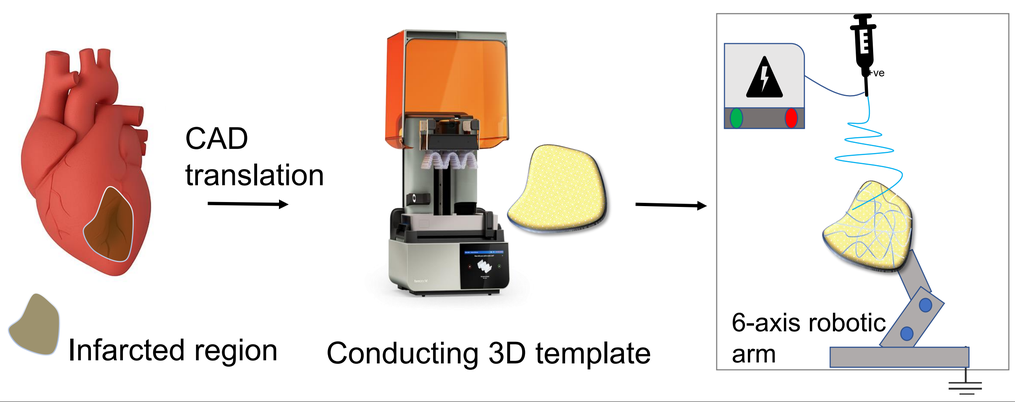
Fetal-like PSC-cardiomyocytes



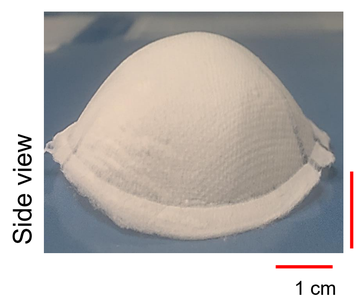
Engineering Shape Memory, Functional 3D Cardiac Patches

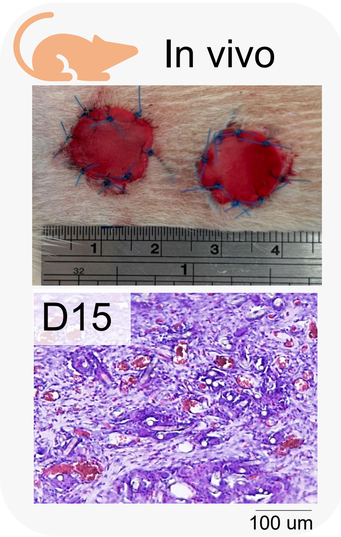
1. Fabrication of Shape Memory 3D Cardiac Patch

(i) Medical Imaging **(ii)** 3D Template Fabrication **(iii)** AJ-3D ES



(iv) 3D Cardiac Patch

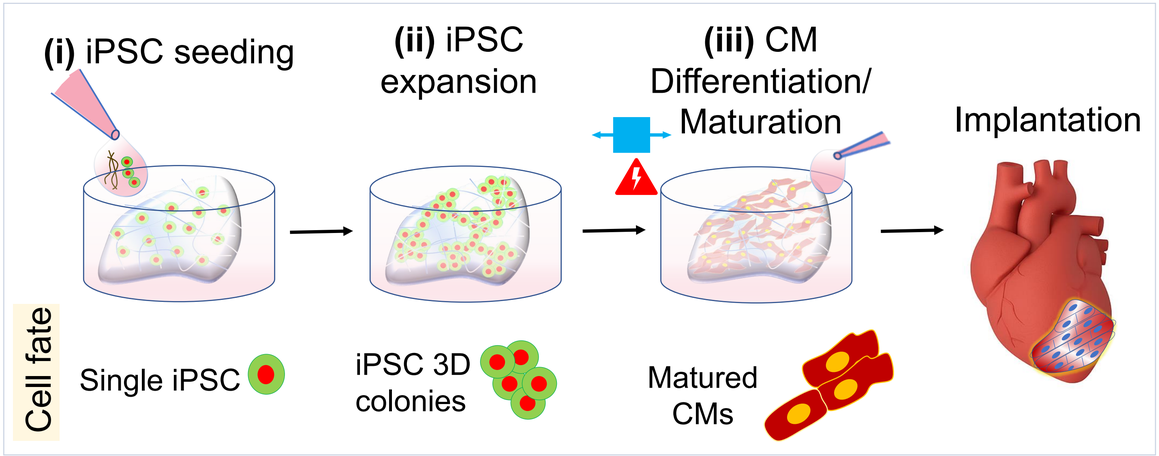




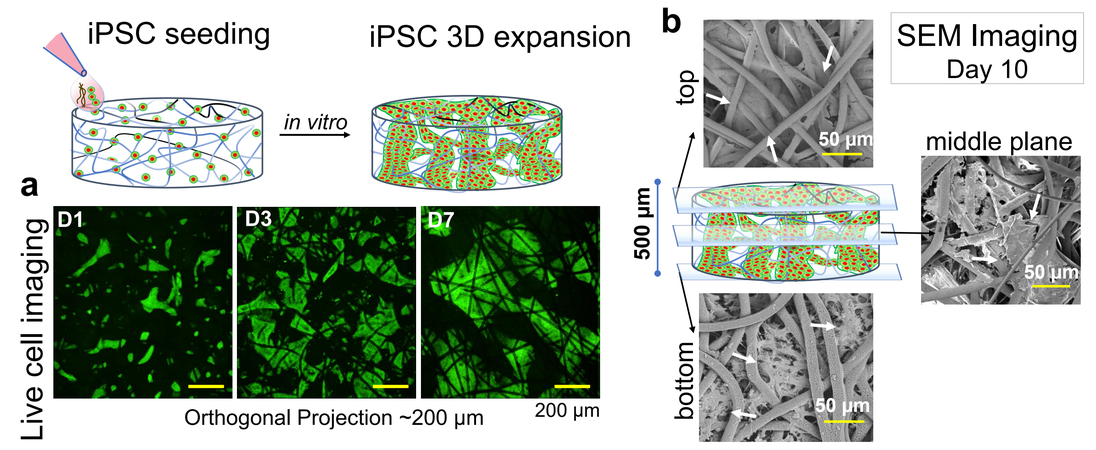
➢ **AJ-3D ES offers**

- ❑ Heart Conforming
- ❑ Shape Memory
- ❑ 10X Stretchable
- ❑ Proangiogenic

2. In-situ CMs Differentiation/Maturation

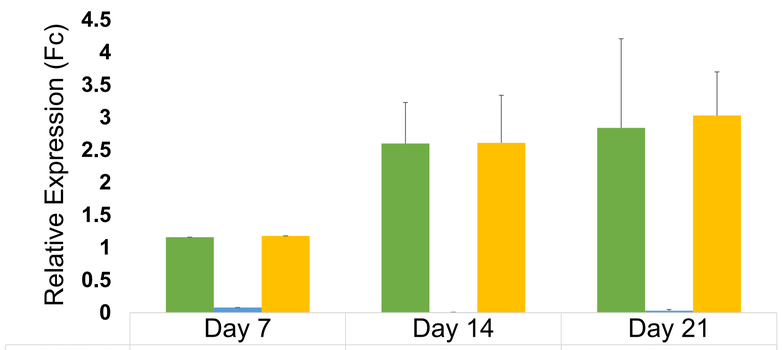


(i, ii) Full-thickness iPSC 3D Colony Formation



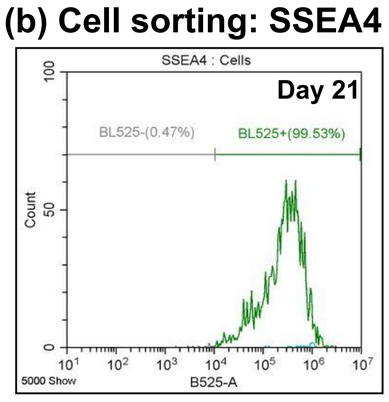
Selective Silencing of SOX2 Gene Exp.

(a) iPSC Pluripotency qPCR Assessment



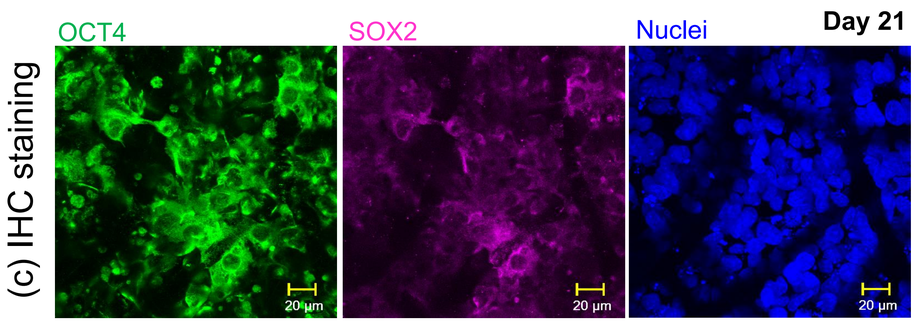
	Day 7	Day 14	Day 21
OCT4A	1.16	2.6	2.84
SOX2	0.08	0.006	0.031
NANOG	1.18	2.61	3.03

(b) Cell sorting: SSEA4

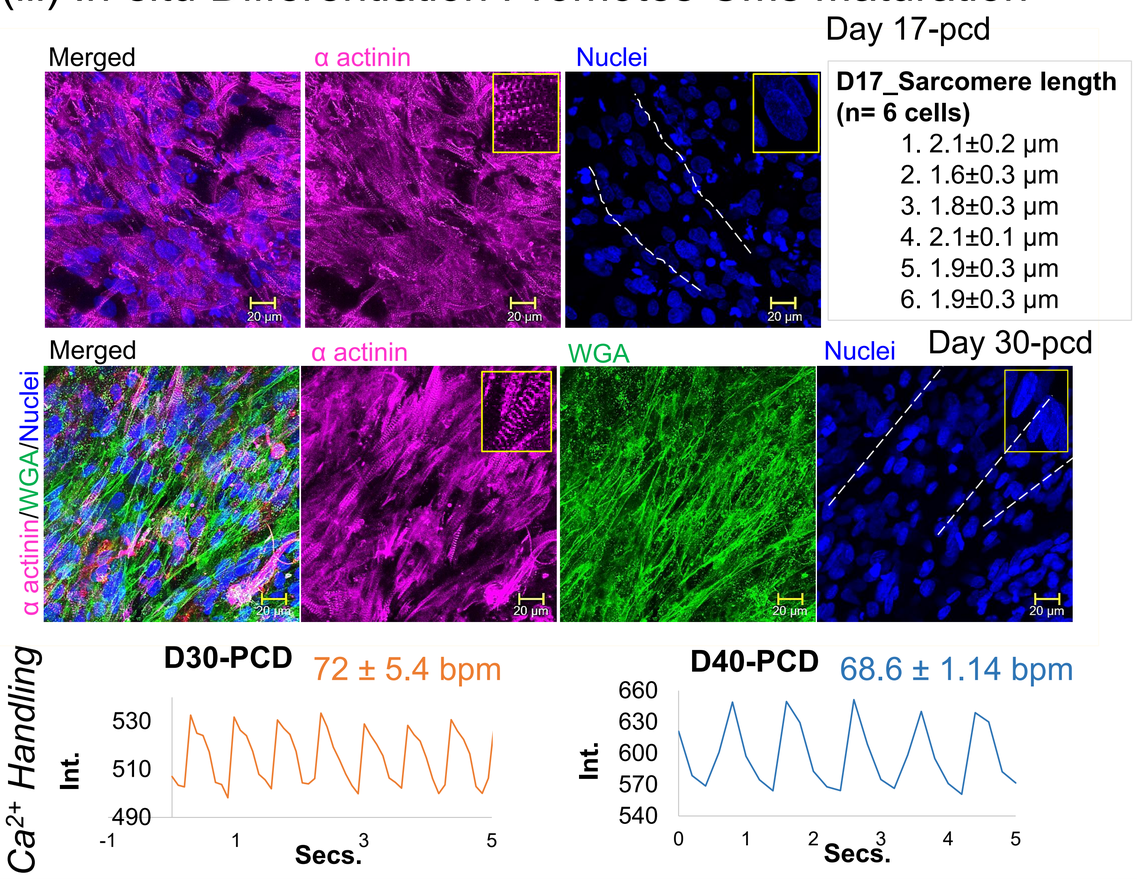


SSEA Positive: **99.53%**

(c) IHC staining



(iii) In-situ Differentiation Promotes CMs Maturation



Conclusion

While AJ-3D ES technique produced scaffolds are anatomical and mechanically enduring, ECM-mimicking 3D environment aid in CM maturation, with **anisotropic cell alignment and sarcomere formation as early as D17.** More fascinatingly, whole circular scaffold (d=15 mm) contraction observation on Day 40-pcd further confirms their **syncytium** across the scaffold.

Future work

- **Perfusion System** adaptation– For thicker constructs
- **CMs hallmark maturation assessment**
- **Electrical/mechanical stimulation or coculture**
- ***In vivo* assessment** of PCL scaffolds in Rat model

References: 1. Nature Reviews Cardiology 17, 341-359 (2020); 2. ACS Appl. Mater. Interfaces 13, 9691-9701 (2021); 3. ACS Appl. Mater. Interfaces 14, 42841-42851 (2022); 4. ACS Appl. Mater. Interfaces 2025, 17, 34, 47878–47893 (2025)

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