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3D-Printed Zone-Specific Meniscus Scaffold from Nanohydroxyapatite-Reinforced Polycaprolactone/ Hydrogel

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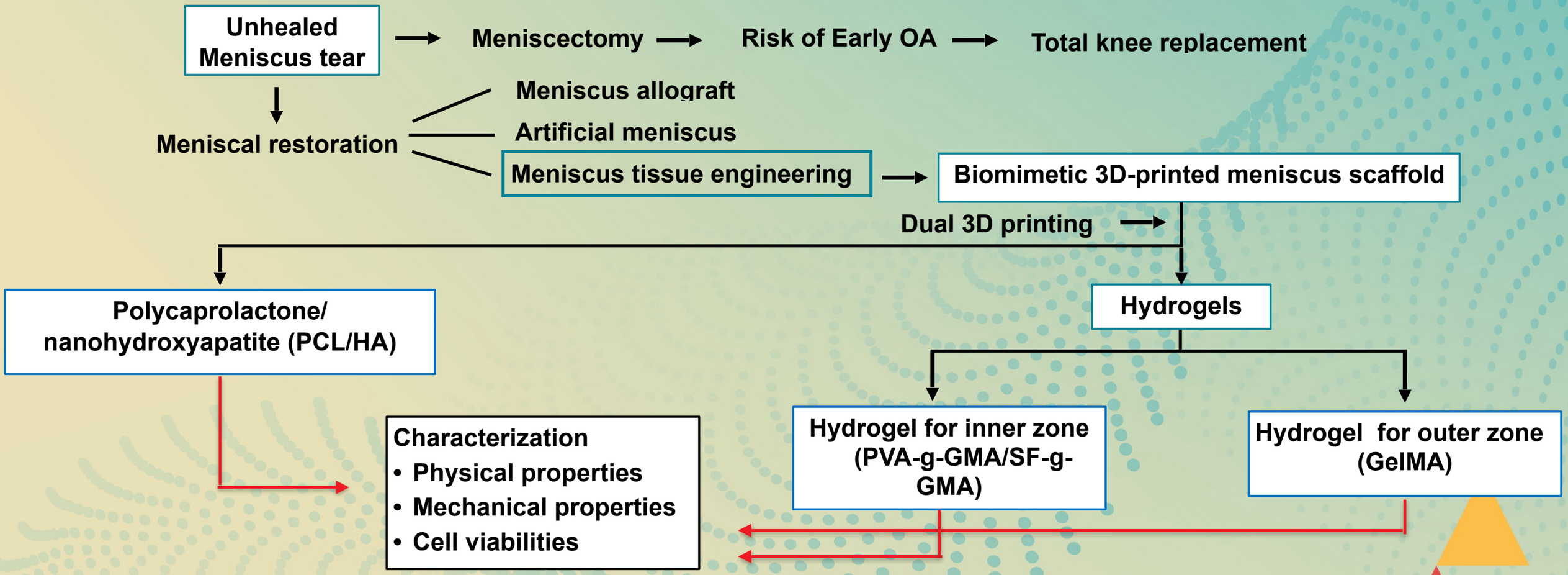
Faculty Disclosure Information

The authors declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this presentation

Introduction



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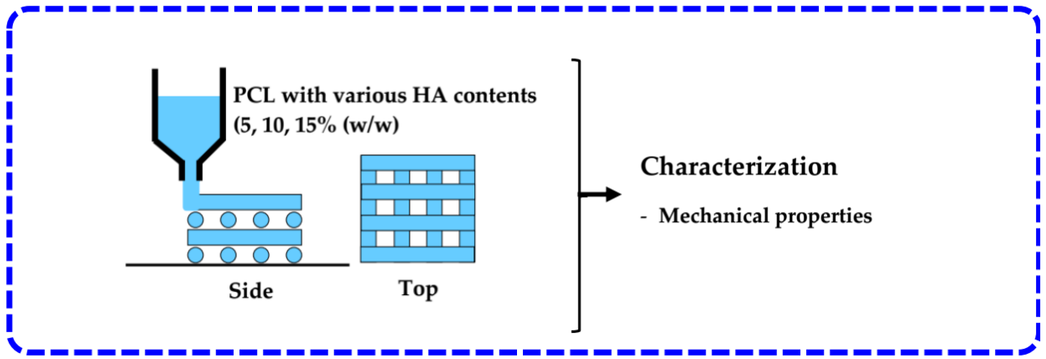
Objectives

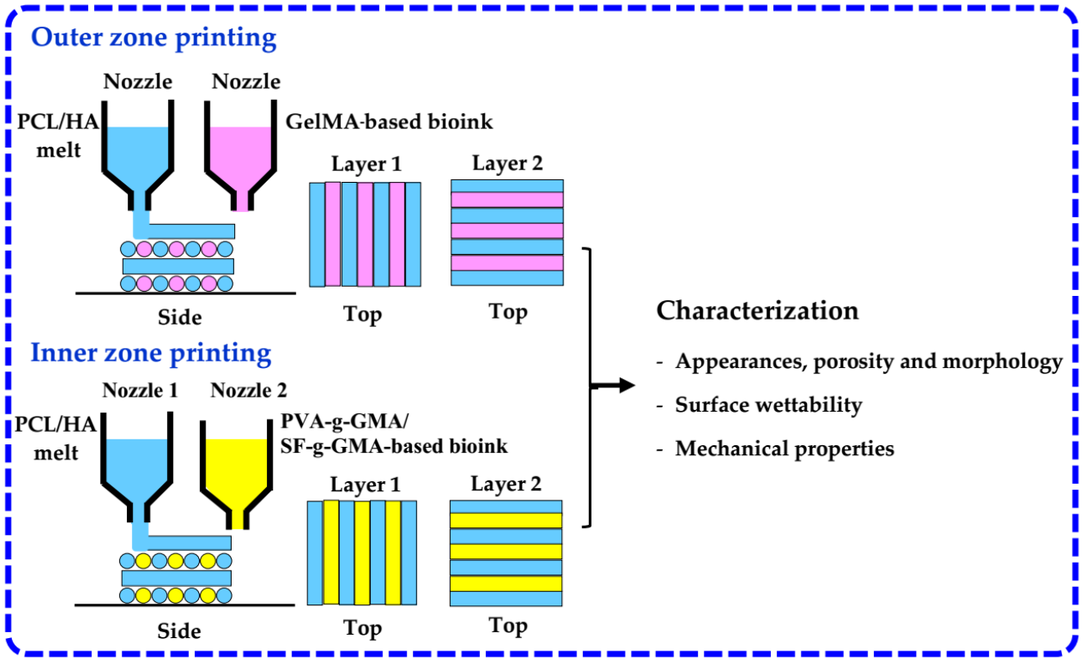
1. To develop a 3D-printed zone-specific meniscus scaffold from HA-reinforced PCL/hydrogel that mimics the native's meniscus
2. To identify identify physical and mechanical properties of this 3D printed-scaffold compare to native meniscus

Methods

Preparation and characterization of 3D-printed PCL/HA



Preparation and characterization of 3D-printed PCL/HA/hydrogel bio-inks



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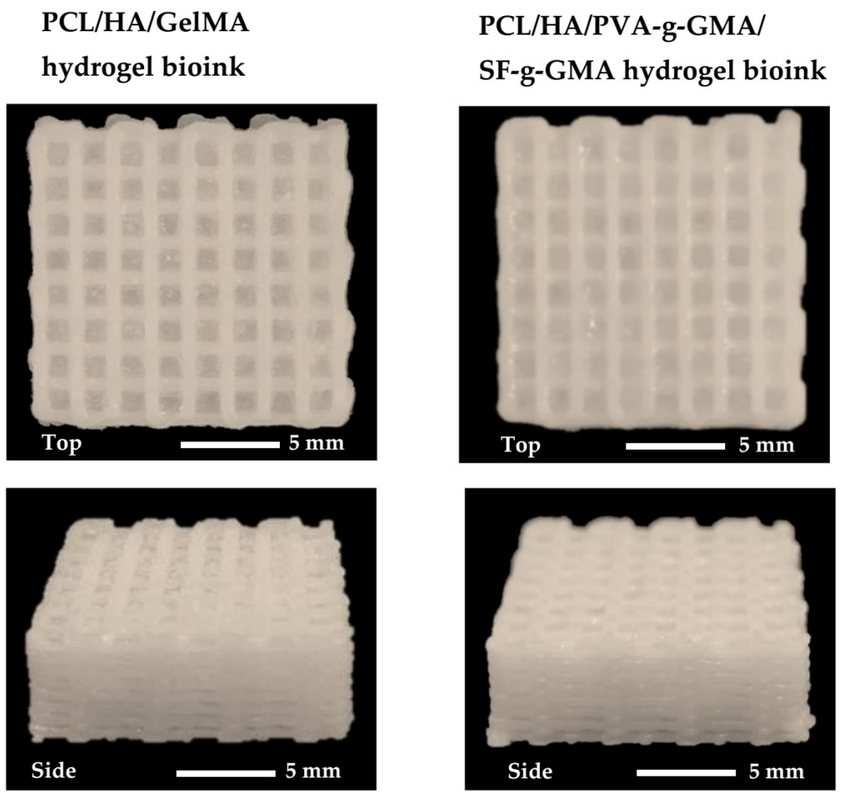
Mechanical properties of 3D-printed PCL/HA

Formulations	Compressive Stress (MPa)	Compressive Modulus (Mpa)	Tensile Stress (MPa)	Tensile Modulus (Mpa)
PCL	17.06 ± 1.31	54.74 ± 6.68	4.53 ± 0.16	49.66 ± 8.60
PCL/5HA	20.39 ± 0.94	51.70 ± 6.34	4.62 ± 0.37	58.07 ± 9.76
PCL/10HA	20.89 ± 1.13	46.19 ± 8.26	4.41 ± 0.23	61.09 ± 6.18
PLC/15HA	17.94 ± 1.34	44.01 ± 3.93	3.54 ± 0.04	51.85 ± 5.06
Human Maniscus	8.77-18.10 [1-2]	0.1-2 [3-7]	3.48-23.54 [8]	75-300 [9]

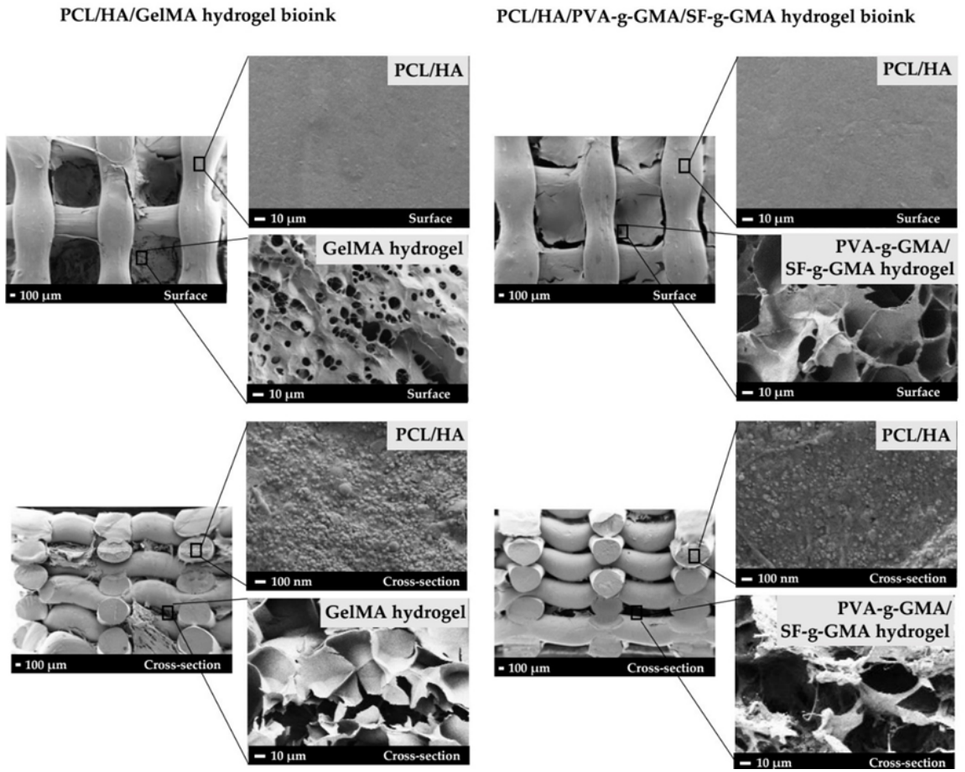
- Adding HA significantly improved the mechanical properties of the 3D-printed PCL composite.
- The PCL/10HA formulation exhibited the highest potential for use in meniscus scaffolds, demonstrating superior compressive and tensile properties that closely resemble those of human meniscus tissue.

Results

Optical appearances of 3D-printed PCL/HA/hydrogel



FE-SEM images of 3D-printed PCL/HA/hydrogel bio-inks



Results

Mechanical properties, porosity and surface wettability of 3D-printed PCL/HA/hydrogel bio-inks

Formulations	Compressive Stress (MPa)	Compressive Modulus (Mpa)	Tensile Stress (MPa)	Tensile Modulus (Mpa)	Porosity (%)	Contact angle (°)
PCL/10HA/GelMA hydrogel	20.67 ± 3.39	31.96 ± 1.53	7.78 ± 0.32	80.35 ± 10.77	34.02 ± 2.18	82.33 ± 2.27
PCL/10HA/PVA-g-GMA/SF-g-GMA hydrogel	21.26 ± 3.58	32.73 ± 1.98	8.05 ± 0.76	89.37 ± 9.01	33.50 ± 3.34	37.00 ± 1.23
Human Maniscus	8.77-18.10 [1-2]	0.1-2 [3-7]	3.48-23.54 [8]	75-300 [9]	33.92 ± 0.03 [10]	

Both zones of 3D-printed PCL/HA/hydrogel scaffolds showed promising properties

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Conclusion

- 3D-printed PCL/HA/GelMA hydrogel for outer zone
- 3D-printed PCL/HA/PVA-g-GMA/SF-g-GMA hydrogel for inner zone
- The mechanical properties and porosity are comparable to those of the human meniscus, with favorable surface wettability.

3D-printed zone-specific meniscus scaffold potentially serve as a biomimetic human meniscus.

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