STEM CELL INNOVATION CONTEST 2026
11TH EDITION | THEME: STEM CELLS & AI
ID: 536
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URINE-DERIVED STEM CELL THERAPY FOR STRESS URINARY INCONTINENCE: Machine Learning–Optimized Gelatin–Alginate Granular Injectable Hydrogel



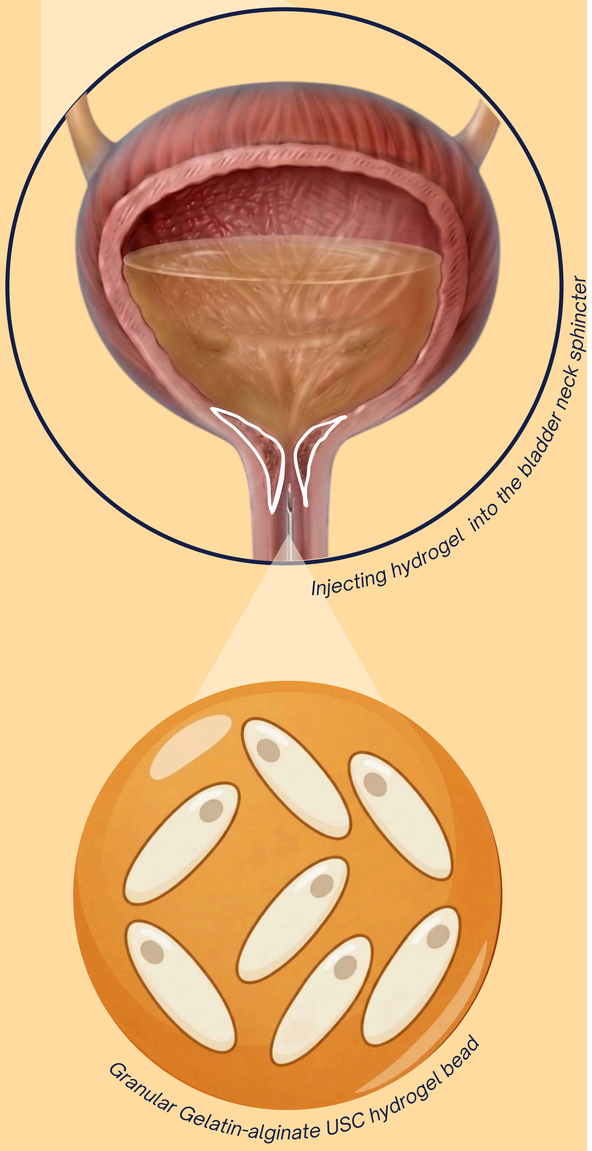
BACKGROUND

Stress Urethral Incontinence (SUI) is the involuntary urine leakage driven by a weakened urethral sphincter, affecting a fraction of adults rising with age. Conservative therapies (bulking agent; sling, artificial sphincter) are low durable efficacy, require repeated injections and rely on foreign materials with risk of erosion.

Urine-derived Stem Cells (USC) are a non-invasive, biopsy-free cell source. They offer rapid proliferation, direct smooth muscle differentiation for sphincter repair, potent paracrine-driven vascularization (VEGF, HGF), and low immunogenicity (HLA-DR negative).

OBJECTIVE

- Develop a machine learning-optimized (ML), injectable granular hydrogel for the encapsulation and delivery of USCs to promote the regeneration of damaged urethral sphincter tissue, with the ultimate goal of restoring urethral closure function and improving urinary continence.
- Offer a potential alternative to invasive surgical treatments.



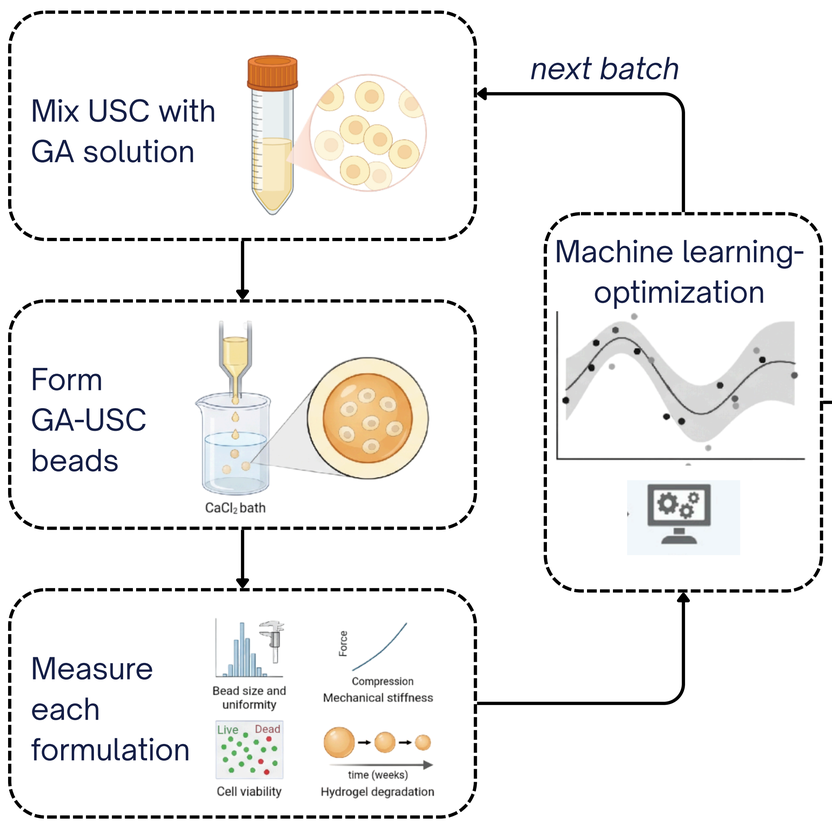
Gelatin-alginate (GA) hydrogel bead
- Biocompatible & biodegradable
- Cell adhesion & proliferation support
- Structural stability

METHODOLOGY

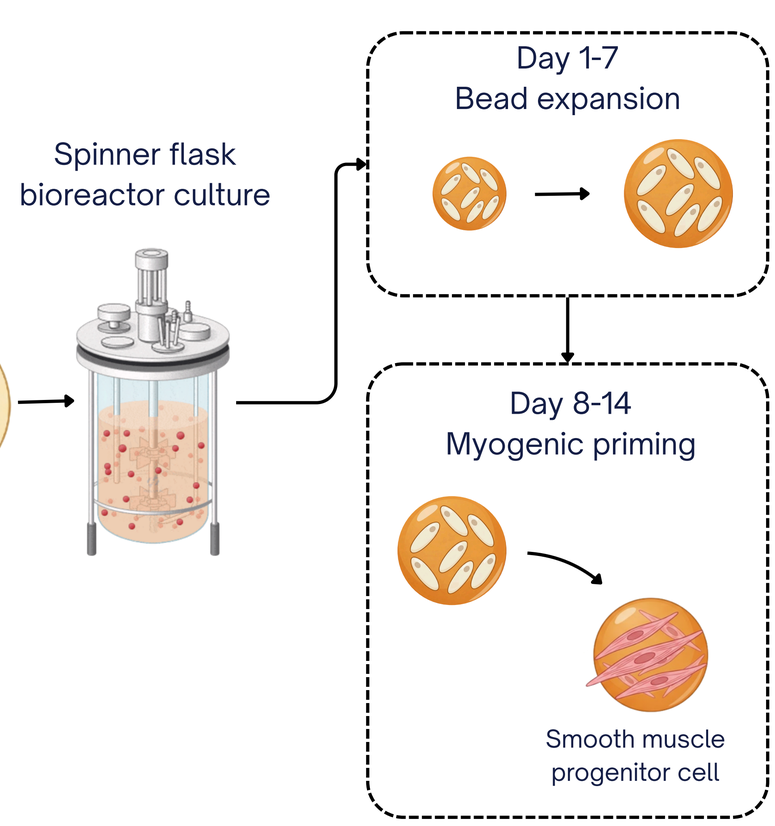
Step 1: USC isolation

Urine samples are collected, centrifuged and cultured.
Adherent colonies with rice-grain-like morphology are selected and expanded in culture.

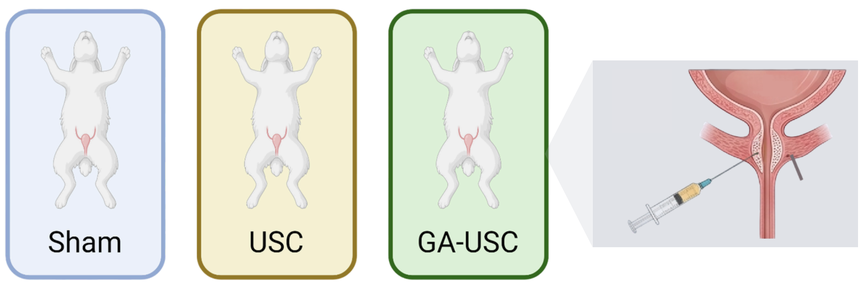
Step 2: ML-optimized granular GA hydrogel fabrication



Step 3: Expansion and myogenic priming



Step 4: Validation



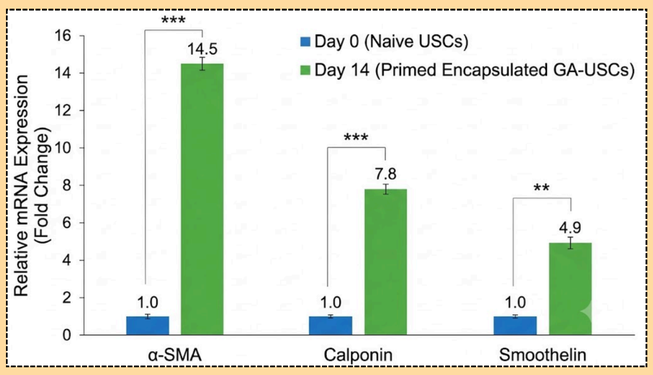
Inject USC-only and GA-USC to SUI-induced rabbits.
Evaluation after 35 days:
- RT-qPCR
- Biodegradation and biocompatibility assays.
- Histology HE staining

EXPECTED RESULTS

Before injection: *In vitro*

RT- qPCR: Encapsulated USCs show successful myogenic priming and smooth muscle lineage differentiation (α-SMA, calponin, smoothelin).

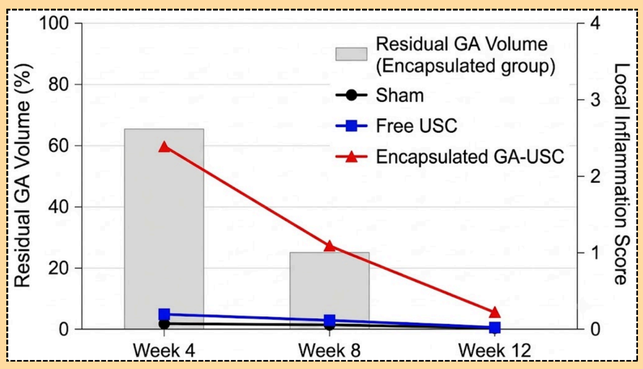
→ **Myogenic Priming**



Smooth muscle marker expression of encapsulated USCs

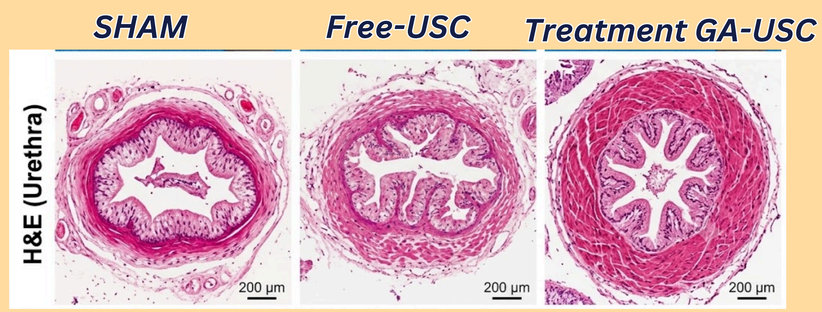
After injection: *In vivo*

Residual GA volume: GA hydrogel safely biodegrades over 12 weeks with minimal inflammation



Biodegradation and biocompatibility of GA hydrogel over 12 weeks.

Regeneration of smooth muscle sphincter layer. Demonstrate the robust regeneration of the smooth muscle sphincter layer in the treatment GA-USC.



Histological evaluation of urethral sphincter regeneration across treatment groups

Reference list

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