Team 11: JBNT Tissue Systems

Synthetic Tissue Phantom

Members: T'yr Simmons-LaRose, Bella Palacio, Jaden Figger, Nora Dores
Mentors: Brent Vernon **ASU**, Chad Van Liere **BD**, Armando Licon **BD**

Ira A. Fulton Schools of Engineering, Arizona State University
School of Biological and Health Systems Engineering

Scan to take a deeper look at our data

Problem and Market Gap

Becton Dickinson (BD) currently validates it core-needle biopsy (CNB) devices using porcine tissues including shoulder muscle, kidney, and connective/fat tissue.

Fig 2. Bard Marquee Device

These tissues degrade quickly, vary between samples, and are unsanitary to work with, creating an opportunity to improve current validation tools consistency and specificity. Our team was tasked with developing a synthetic tissue phantom that replicates the mechanical properties of these tissues, with contiguity as the primary acceptance criteria. The goal is a reproducible, tunable, and safe alternative to animal tissue for CNB device validation.

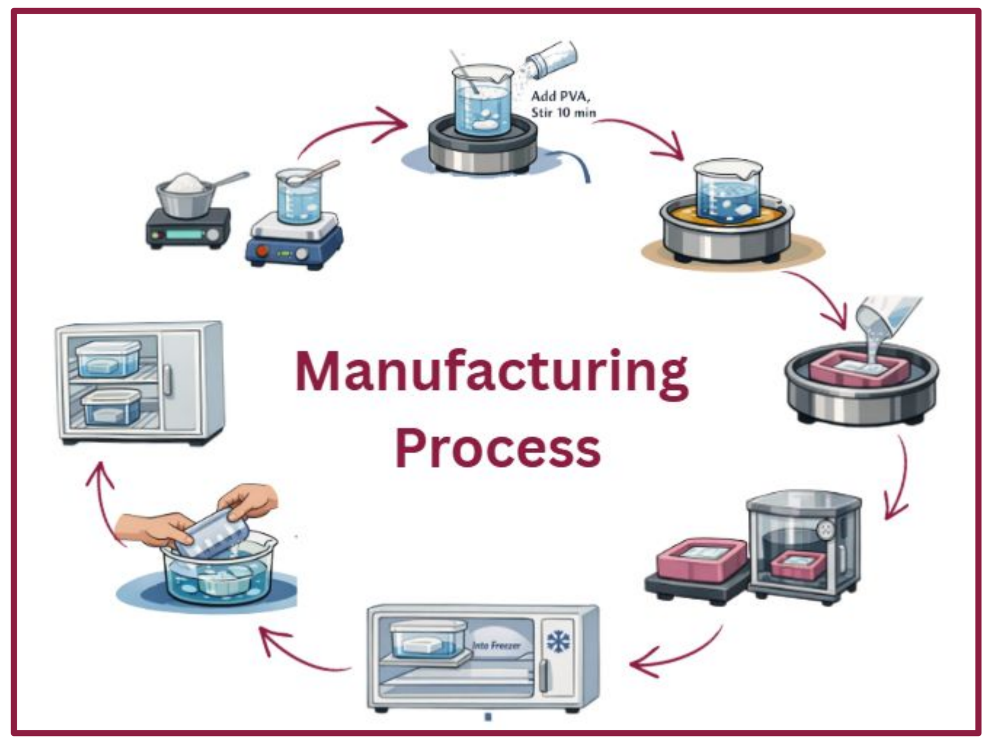
Design Requirements

- Match mechanical properties (stiffness, elasticity, contiguity) of the three target tissue types (fat, kidney, and muscle)
- Prioritize contiguity, BD's primary acceptance criteria
- Reproducible and consistent across samples and batches
- Safe, non-biohazardous, compatible with CNB devices
- Tunable properties via solute concentration and freeze–thaw cycling

Prototype Experimental Matrix

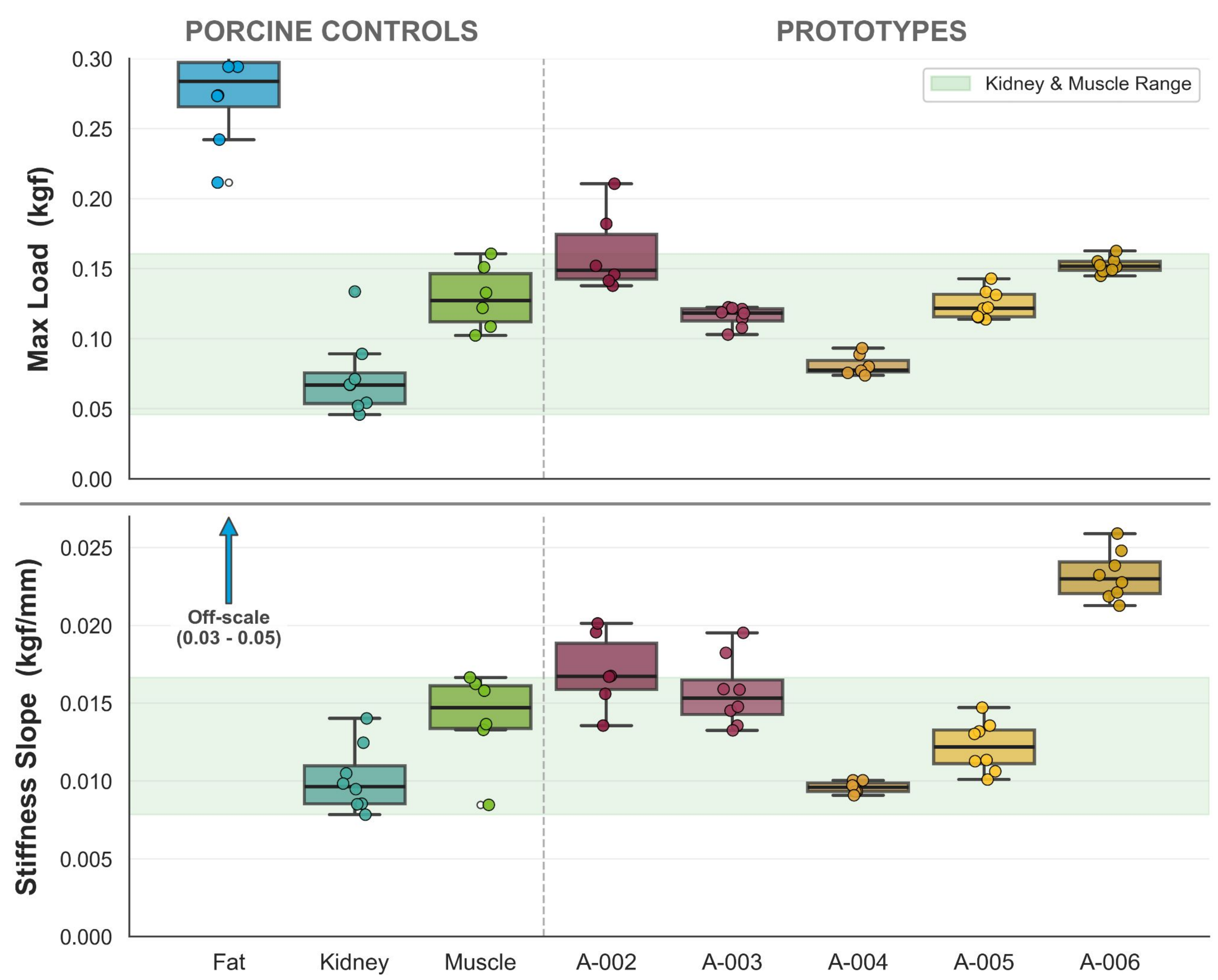
Prototype	Solute w/v %	FT Cycles
ALPHA-001	9.09%	N/A
ALPHA-002	7.74%	3
ALPHA-003	8.60%	3
ALPHA-004	8.33%	2
ALPHA-005	8.33%	3
ALPHA-006	8.33%	4

Manufacturing Process



1. Pre-weigh beaker, stir bar, and DI water; add solute at room temperature with magnetic stirring
2. Heat in a silicone oil bath with a vented foil cover to minimize evaporation
3. Re-weigh post-mix to calculate the corrected solute concentration delivered to the mold
4. Pour into a silicone mold and degas in vacuum chamber
5. Transfer to freezer to start freeze–thaw cycles.
6. Demold, submerge in DI water, and store refrigerated until testing

14G Instron Test Results | Control vs. Prototypes



14G CNB Instron Results. Max load (top) and stiffness slope (bottom) across porcine controls and cryogel phantoms. All prototypes fall within the porcine kidney/muscle range (shaded).

Key Findings & Limitations

Findings:

- Refined double-boiler process produces cryogels while minimizing burning.
- All prototypes meet BD's primary contiguity criteria.
- Stiffness and max load for ALPHA-002 through ALPHA-006 fall within the porcine kidney/muscle range at both needle gauges
- Freeze–thaw cycle count is a meaningful tuning variable at fixed solute concentration, though the relationship is nonlinear.

Limitations:

- The cryogel alone likely can not reach porcine fat stiffness or max load
- Small sample size (n = 6 per gauge) limits statistical power
- Lab freezer operated at around -12-15 °C vs the goal of −20 °C, which may impact mechanical properties.
- Difficult to achieve intended solute concentration despite using a cover over the beaker.

Future Directions

- **ALPHA-007:** Best estimated solute % combination targeting porcine fat, extrapolated manually from the ALPHA-002–006 mechanical testing data.
- **ALPHA-008:** Cryogel composite testing whether starch fillers can reduce elasticity and extend the mechanical properties beyond what freeze–thaw tuning alone can achieve.

Refinements to the acceptance criteria for a synthetic medium replicating biological tissues is needed. The Instron and contiguity tests are incomplete and are not sufficient enough to draw final conclusions from.

Acknowledgements

We would like to express our gratitude to Dr. Brent Vernon, Chad Van Liere, and Armando Licon for continual input and making our work possible.