CEMB
Center for Engineering MechanoBiology

RESEARCH EXPERIENCE FOR TEACHERS

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The Mechanical Properties of Intestines and Rat Tail Tendon Fascicles

Tendon isolation

Note: Always keep the tendon hydrated, either soaked in phosphate buffered saline (PBS) or moisten with the spray bottle.

1. Isolate at least one tendon following the presentation and video. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3156064/

Sample preparation

1. For intestine, measure the width and height three times along the sample length. Calculate their averages and the sample cross-sectional area (A), assuming a rectangular cross-section. For tendon, calculate A, assuming a circular cross-section.

Intestine	Width (m)	Height (m)	Average width (m)	Average height (m)	Cross-sectional area (A, m^2)
1a					
1b					
1c					
Tendon	Diameter (m)	Average diameter (m)	Cross-sectional area (A, m^2)		
2a					
2b					
2c					

2. For the bottom clip, record the weight of the clip and wire. Using clips, sandpaper, and superglue, clamp the ends of the sample. Measure the length of the sample between the clips, while on a flat surface. Cut the sample if it is too long.

Weight of clip + wire (gm) – this is your initial weight	
Length of intestine (m)	
Length of tendon (m)	

Sample loading

1. Hang the clamped sample. Measure the length of the sample between the clips. Add the smallest weight and measure the length. Continue to add weights and measure the length until either the sample fails or slips from the grips.

Intestine

Weight (gm)	Length (mm)

Tendon

Weight (gm)	Length (mm)

Calculations

1. Convert your weights data to force. Calculate the change in length or elongation from the sample length data. Then, calculate stress and strain.
   Stress=F/A
   Strain ($\Delta L/L$)

Intestine

Force (F, N)	Elongation (ΔL, m)	Stress (Pa)	Strain (unitless)

Tendon

Force (F, N)	Elongation (ΔL, m)	Stress (Pa)	Strain (unitless)

2. For each sample, plot the stress-strain curve. If you see a toe region, estimate where you think the toe region ends (report the strain). Calculate the slope of the linear part of the curve, which is the elastic modulus (Pa).

	End of toe region (strain)	Slope (Pa)
Intestine		
Tendon		

<u>Open-ended questions</u>

1. Look up the reported value of the elastic modulus of intestine and tendons. Calculate the % error of your measurements compared to literature values. What factors do you think may have caused this error?
2. Compare the elastic modulus of intestine with that of tendon. Which one is stiffer? Does this make sense physiologically?
3. Were you able to watch the sample fail before slipping out? If not, assuming that the intestine fails at 30% strain and the tendon fails at 10% strain, calculate how much force (or weight) the sample could hold before reaching failure, based on the elastic modulus values you calculated.
4. Collagen generally aligns in the direction of applied force. Knowing this, do you think we tested the soft tissues properly? If not, how would you change the mechanical testing to better reflect how the tissue performs in vivo?

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