BME 309
TISSUE ENGINEERING
Journal Club

Nanofiber Scaffolds with Gradations in Mineral Content for Mimicking the Tendon-to-Bone Insertion Site

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Introduction

Provide function, structure, and composition of native tissue in a few slides

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Introduction

Problem: The unique transitional (interface) tissue between tendon and bone is not recreated during tendon-to-bone healing.

Fact: The natural tendon-to-bone attachment relies on a gradient in structure and composition that translates into a spatial variation of mechanical stiffness.

Hypothesis: The gradation in mineral content can result in a spatial variation in the stiffness of the scaffold and thus be potentially used for repairing the tendon-to-bone insertion site via a tissue engineering approach.

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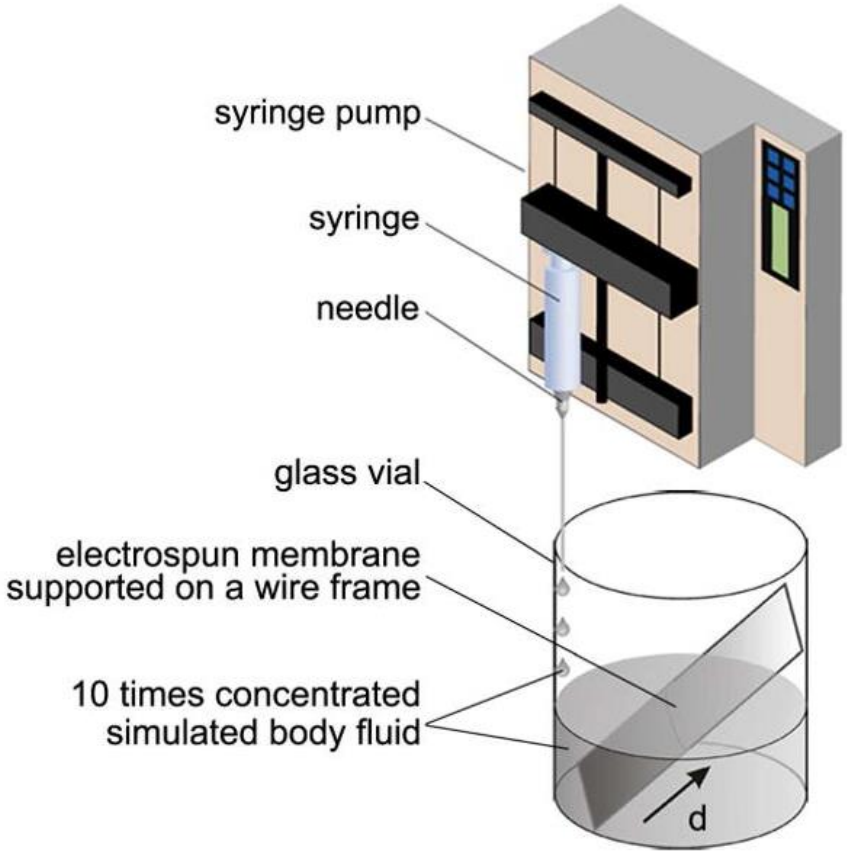
Experimental:



- A schematic of the procedure for generating a graded coating of calcium phosphate on a nonwoven mat of electrospun nanofibers.
- Ten times concentrated simulated body fluid was added at a constant rate to linearly reduce the deposition time from the bottom to the top end of the substrate.
- The parameter *d* refers to the distance from the bottom edge of the substrate

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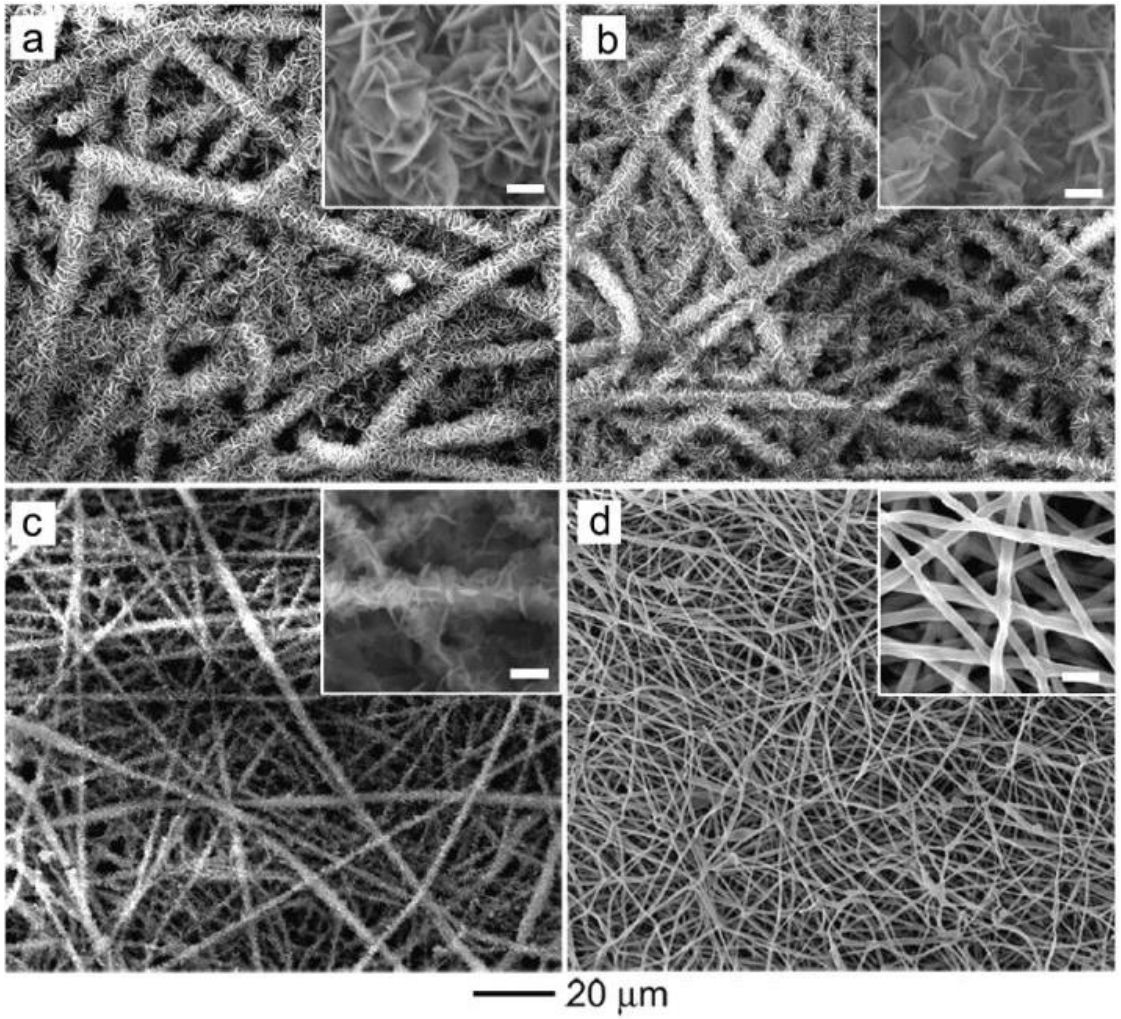
Results:



- SEM images of calcium phosphate coatings on a plasma-treated nonwoven mat of PLGA nanofibers.
- The images were taken from different regions, with *d* corresponding to: (a) 0, (b) 6, (c) 9, and (d) 11 mm.
- The scale bars in the insets are 2 µm.

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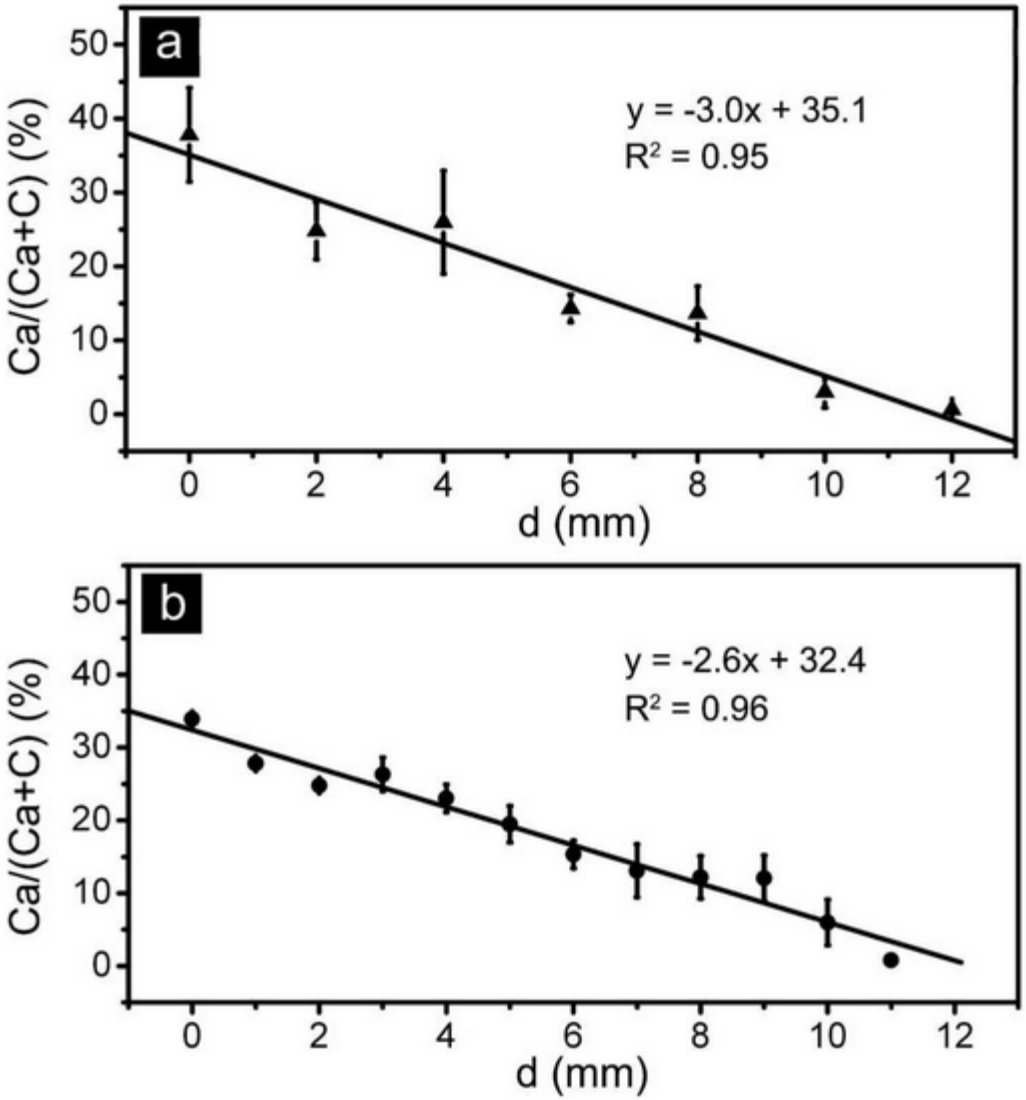

- Characterization of the mineral content
- The plots show average calcium content as a function of *d* along the direction of gradient for (a) plasma-treated PLGA scaffolds and (b) gelatin-coated PCL respectively

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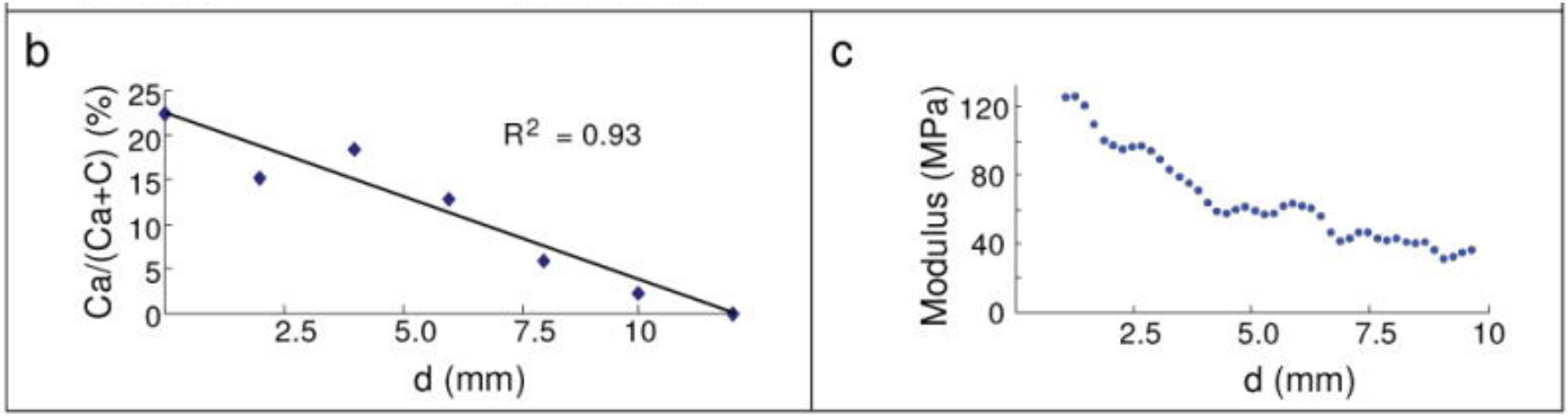

- Mechanical testing of the graded scaffolds.
- There was a gradation in mechanical properties along the length of the scaffolds (a representative PLGA scaffold is shown).
- (b) There was a linear decrease in calcium phosphate along the length of the scaffold.
- (c) Young's modulus decreased with decreasing calcium phosphate content.

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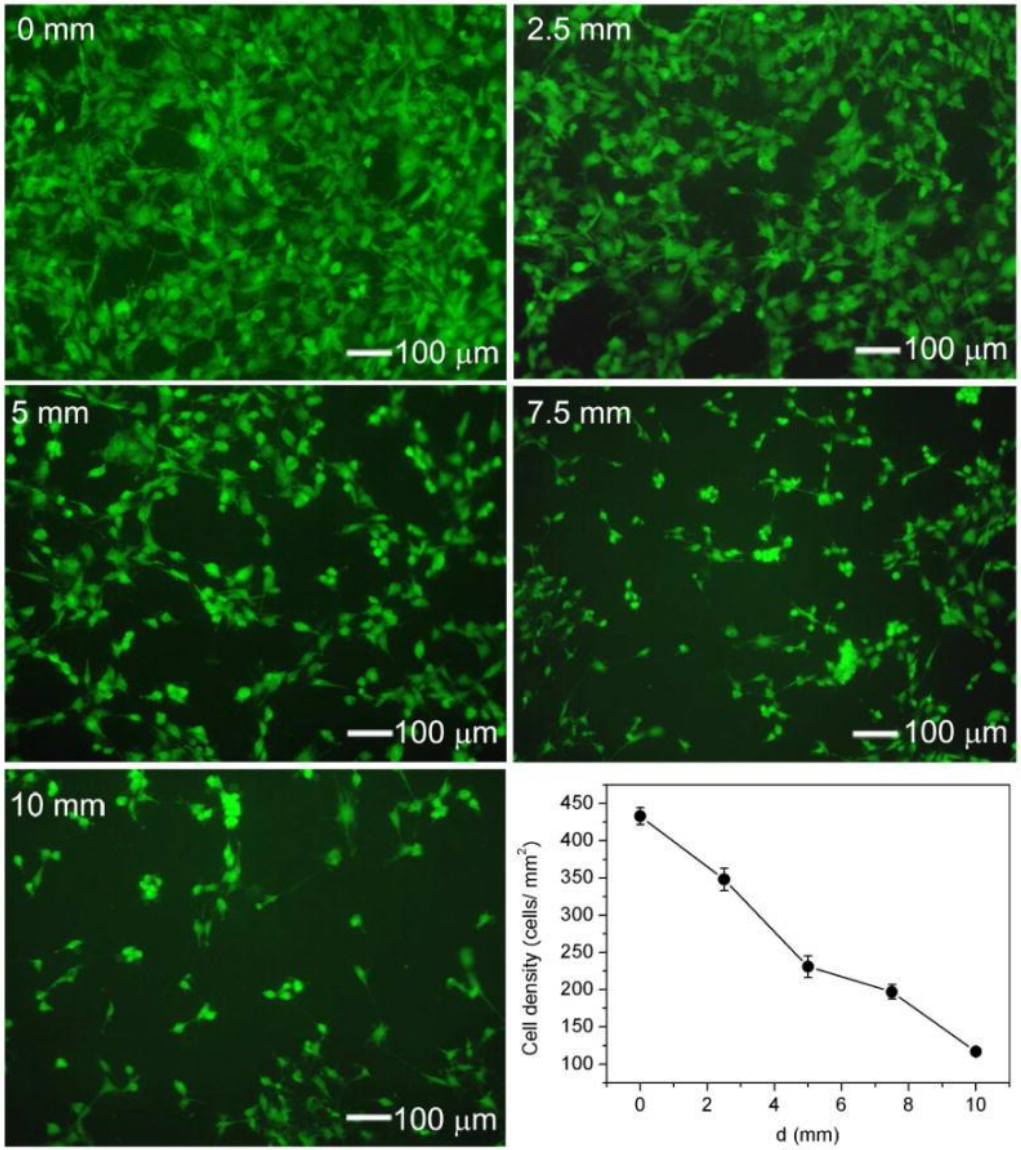

- Cell culture data for the graded scaffolds.
- Fluorescence micrographs of MC3T3-E1 cells cultured on a graded scaffold made of gelatin-coated PCL nanofibers for 3 days and the average cell density as a function of *d* along the gradient.
- The images were taken from different regions (as indicated by *d*) along the gradient of calcium phosphate.

Criticism:

- The study generates a graded structure at a distance of 12mm, which is not physiologically relevant. In native tendon-bone interface the gradient occurs approximately within 120 microns.

Conclusions and Future Perspectives:

- The approach demonstrated here might offer engineered scaffolds that can closely match the tendon-to-bone insertion site

- In future studies, we will seek to combine these engineered scaffolds with mesenchymal stem cells to enhance tendon-to-bone healing in a rat rotator cuff injury and repair model