New tricks for old materials: The Glycomer™ 631 case

NUI Galway- UL Alliance 5th Postgraduate Research Day

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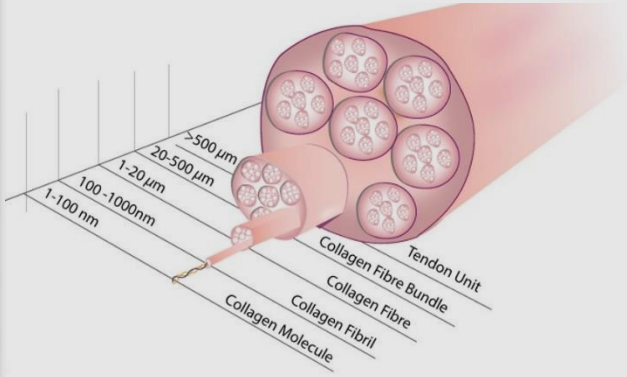
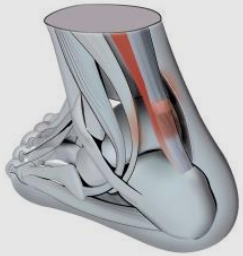
Tendon repair: state of art and limitations

Tendon

Tendon tissue structure



Tendon Injuries



Slow healing
Pain
Recurrent character

Current solutions in clinic and in preclinical models

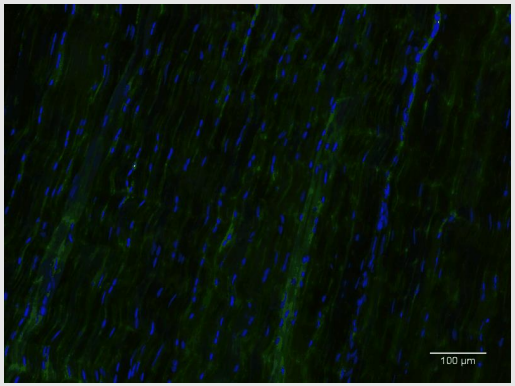
Tissue Grafts

High failure rate

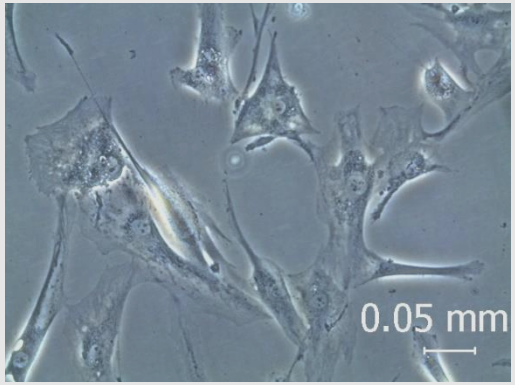
Injectable systems

Small defects only
Poor cell retention

Growing tenocytes *in vitro*: Far from reality

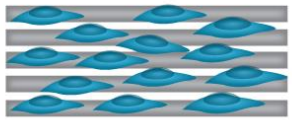
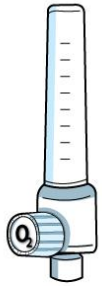
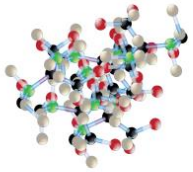
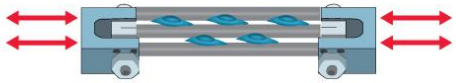
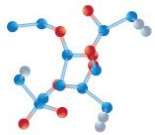
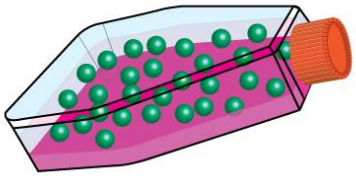
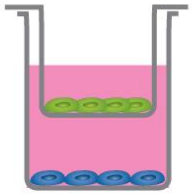
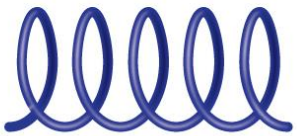
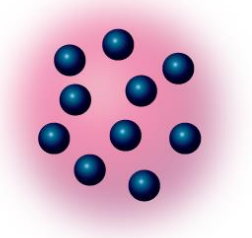


Tendon complex microenvironment



Phenotypic drift *in vitro*

In vivo microenvironment recapitulation toolbox

Biophysical Beacons	Biochemical Cues	Biological Signals
Topography 	Oxygen Tension 	Growth Factors 
Mechanical Loading 	Ascorbate 	Genes 
Macromolecular Crowding 	Glucose 	Co-Culture 
Stiffness 	Amino Acids 	Cytokines 

K. Spanoudes *et al.*, Trends in Biotechnology (2014)

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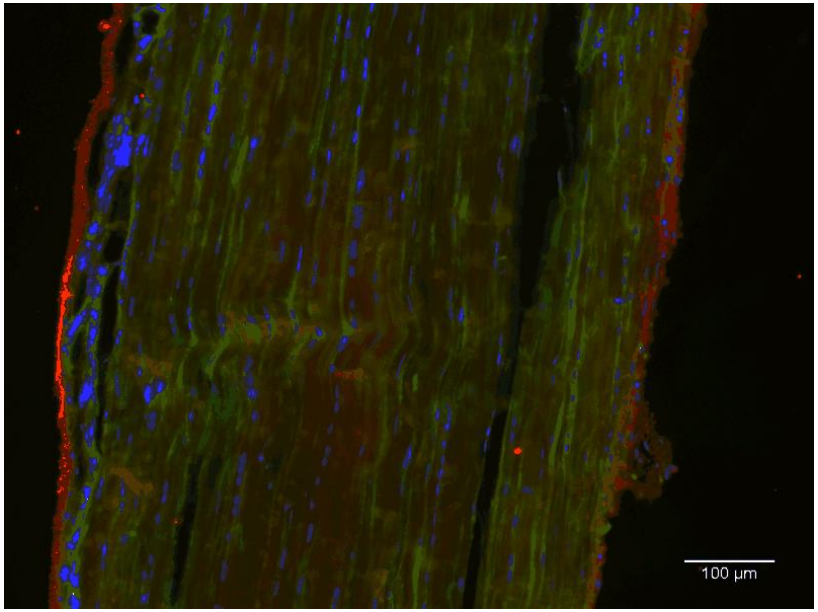
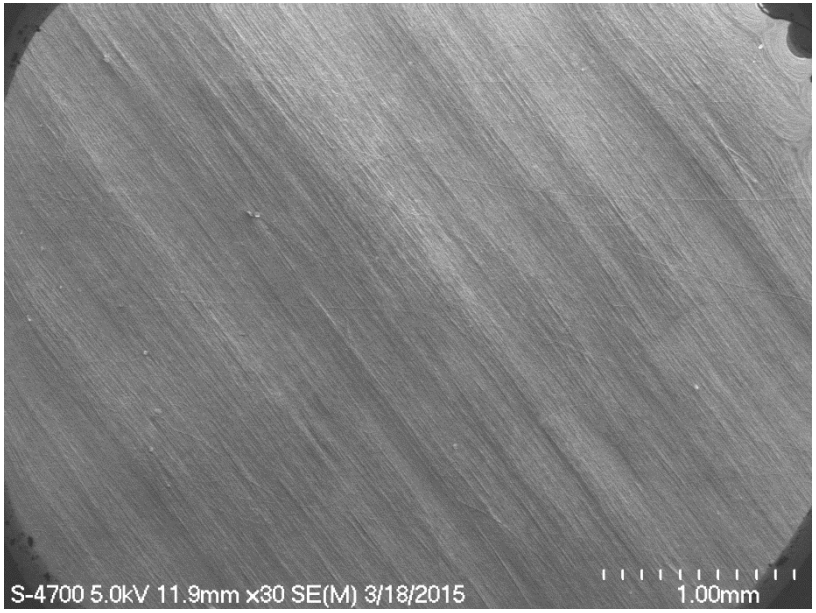
Glycomer™ 631



Synthetic absorbable suture

60 % Glycolide
26 % Trimethylene Carbonate
14 % Dioxanone



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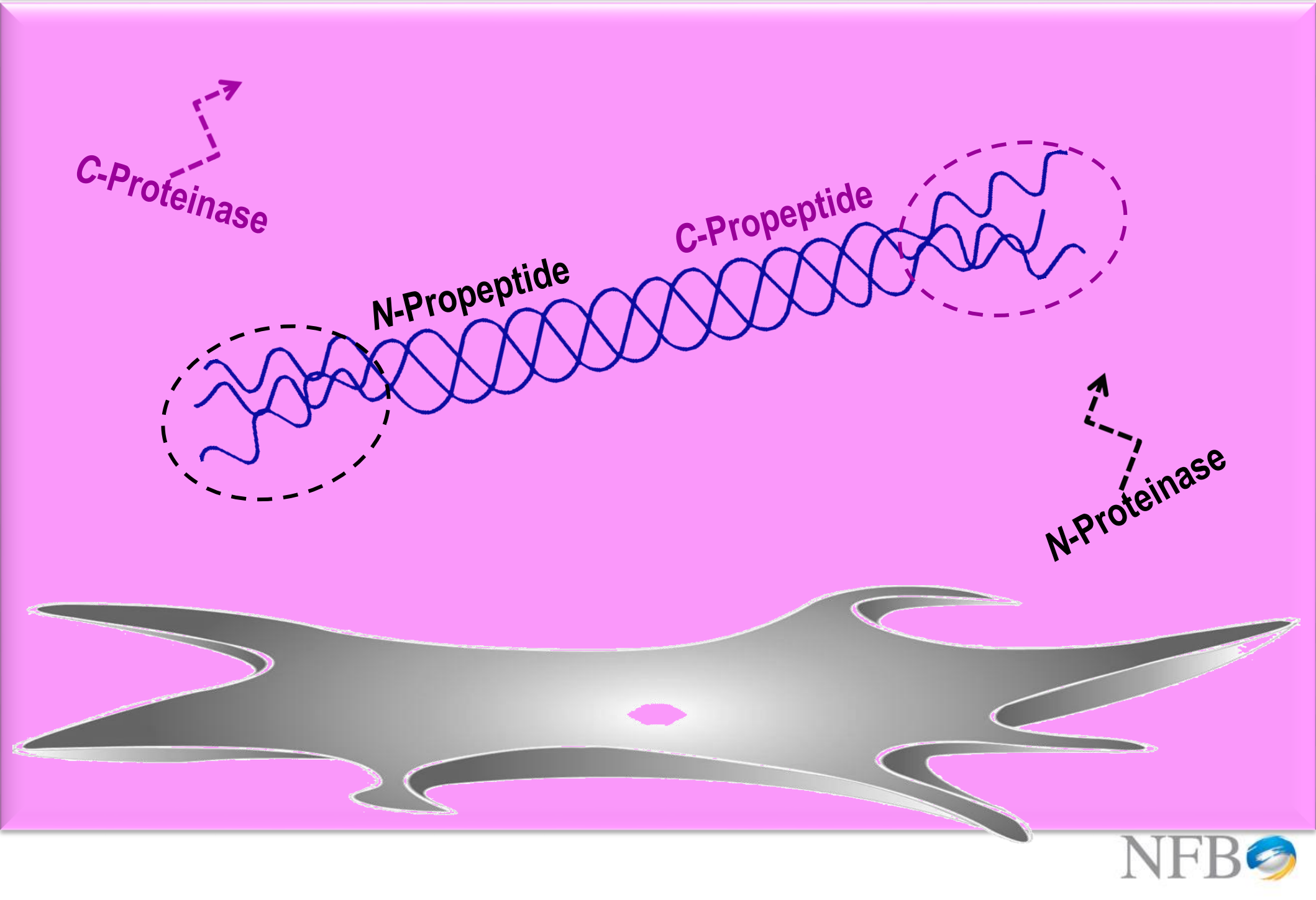
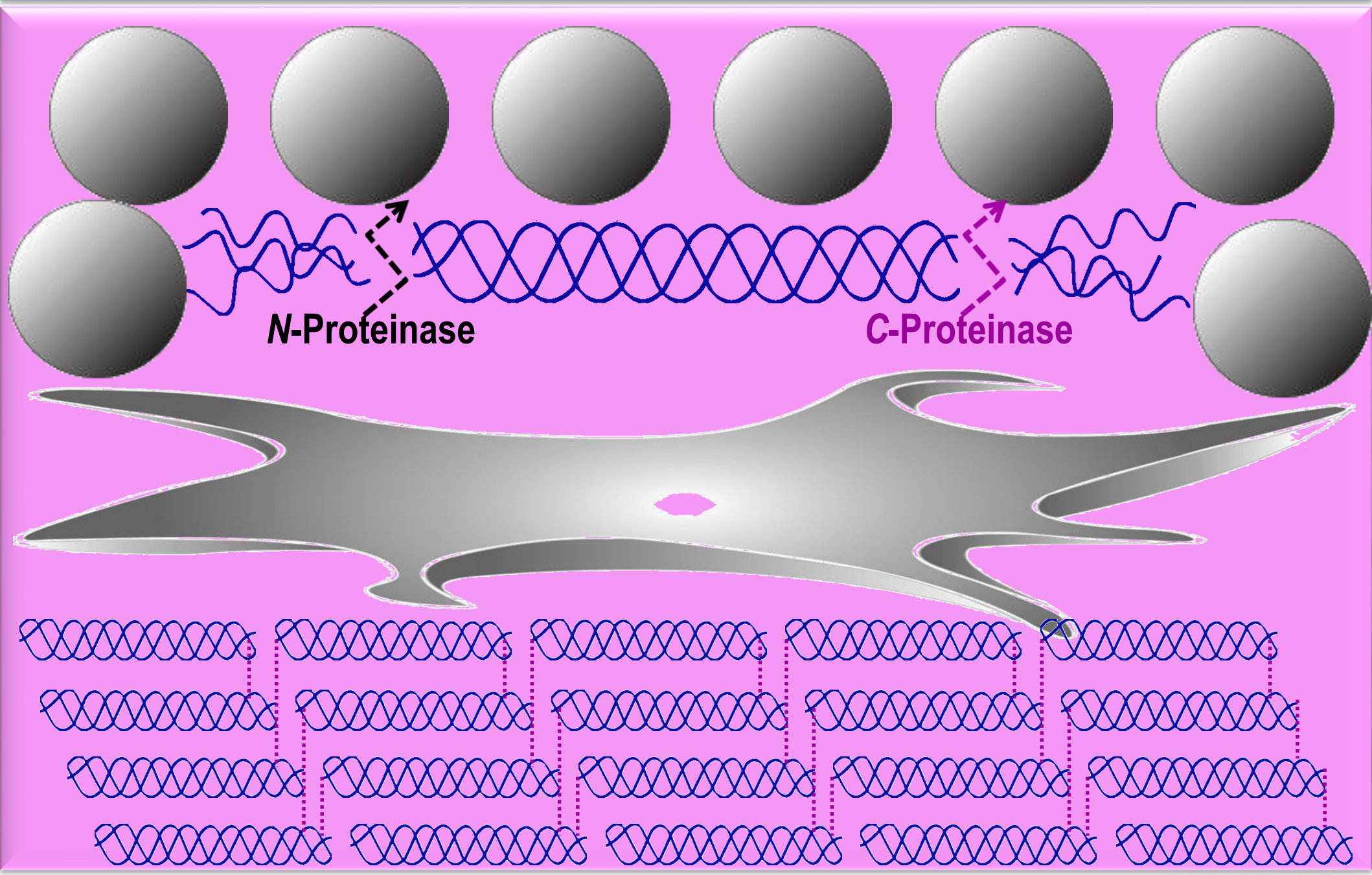
In vitro collagen biosynthesis

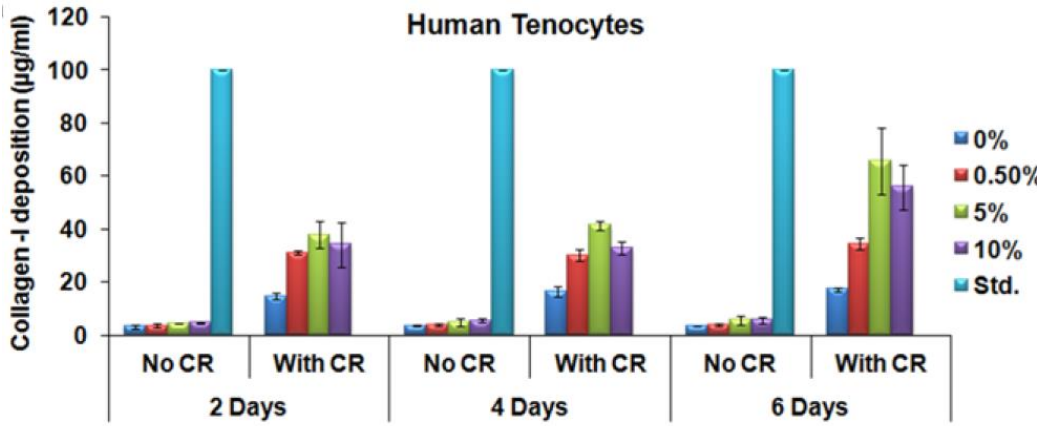


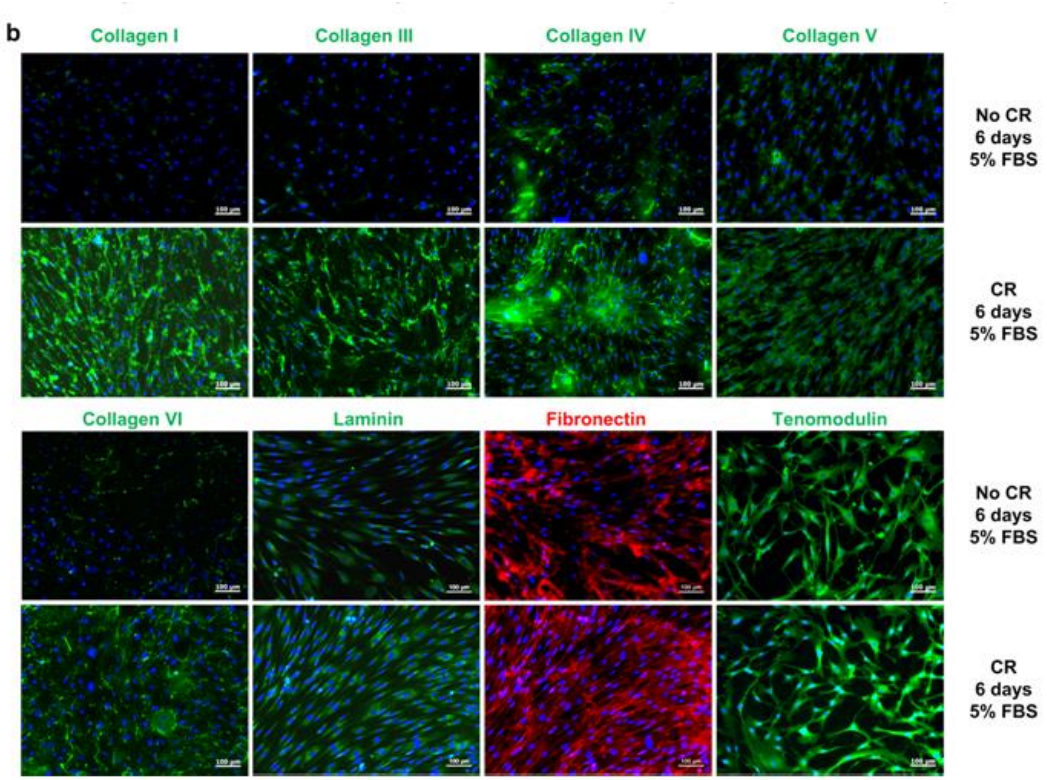
Macromolecular crowding and collagen biosynthesis



Macromolecular Crowding

Tendon-specific ECM deposition





Human Tenocytes, P: 4, Carrageenan (CR) 75μg/mL, FBS concentrations in %, Std: Symatese bovine collagen I (100µg/ml)

Satyam et al-Advanced Materials 2014

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Hypothesis

Glycomer™ 631, can be utilised for the fabrication of an aligned nanofibrous scaffold and in combination with macromolecular crowding will promote tenogenic phenotype maintenance *in vitro*

Objectives

- ❑ Fabrication of an aligned electrospun Glycomer™ 631 scaffold
- ❑ Evaluation of Glycomer™ 631 scaffold as tenocyte carrier *in vitro*
- ❑ Utilisation of Glycomer™ 631 in combination with other cues

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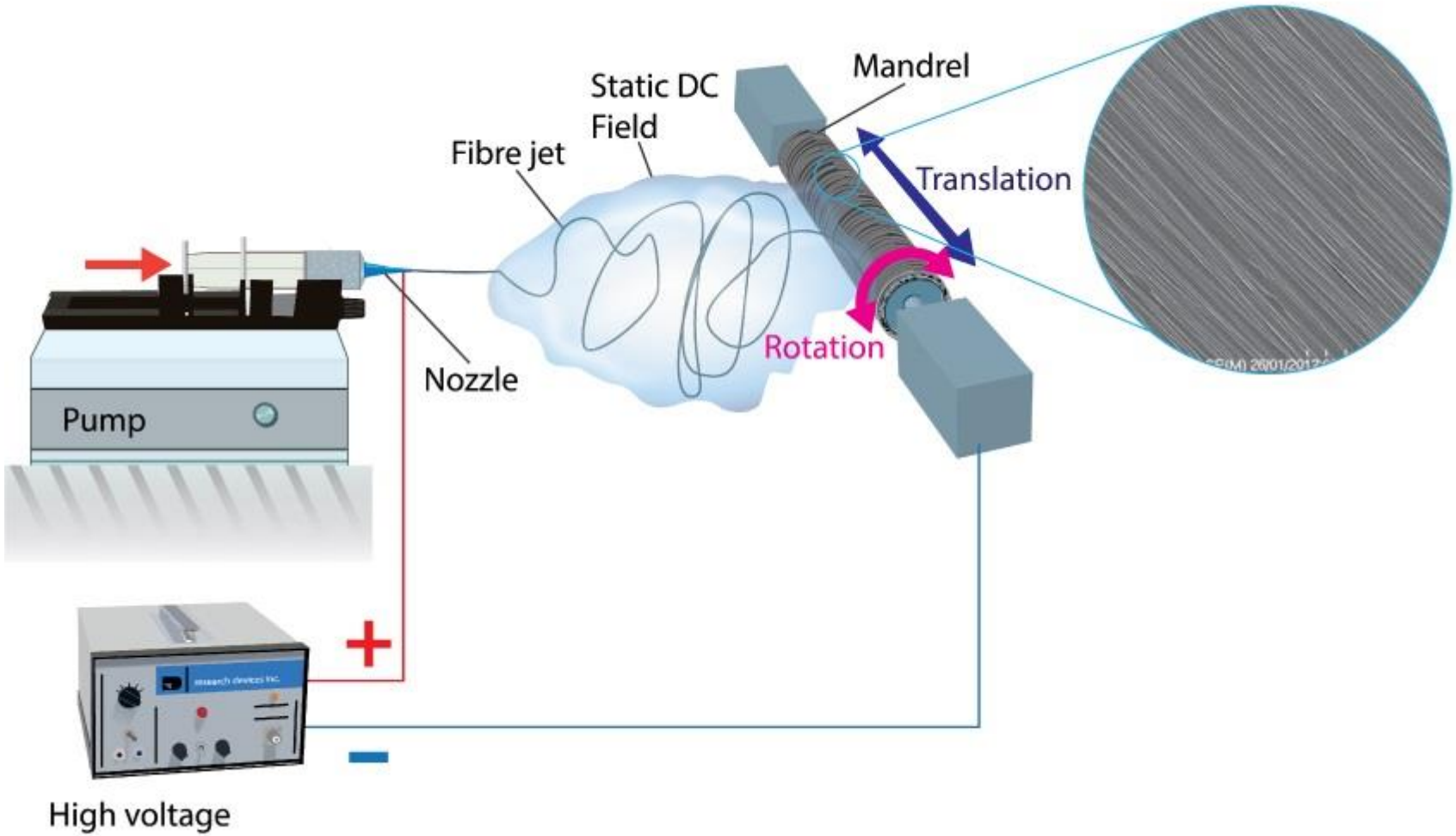
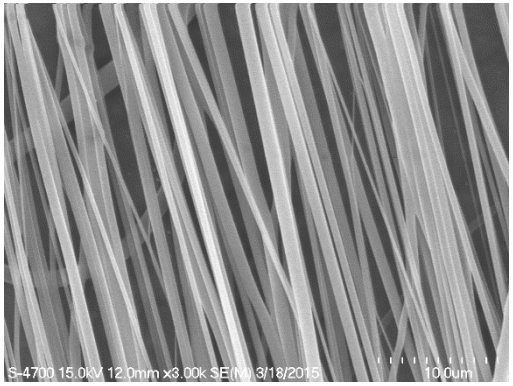
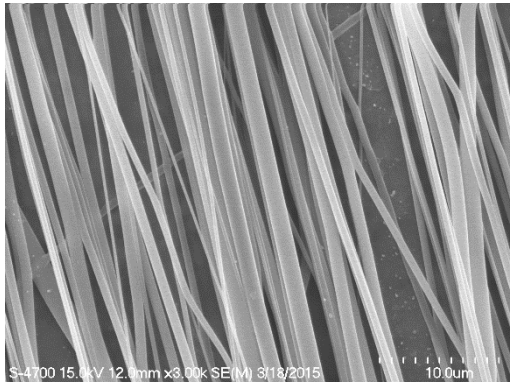
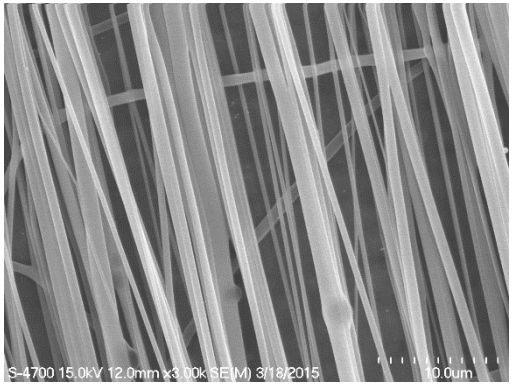
Electrospinning technology



Scaffold characteristics : Alignment and fiber diameter

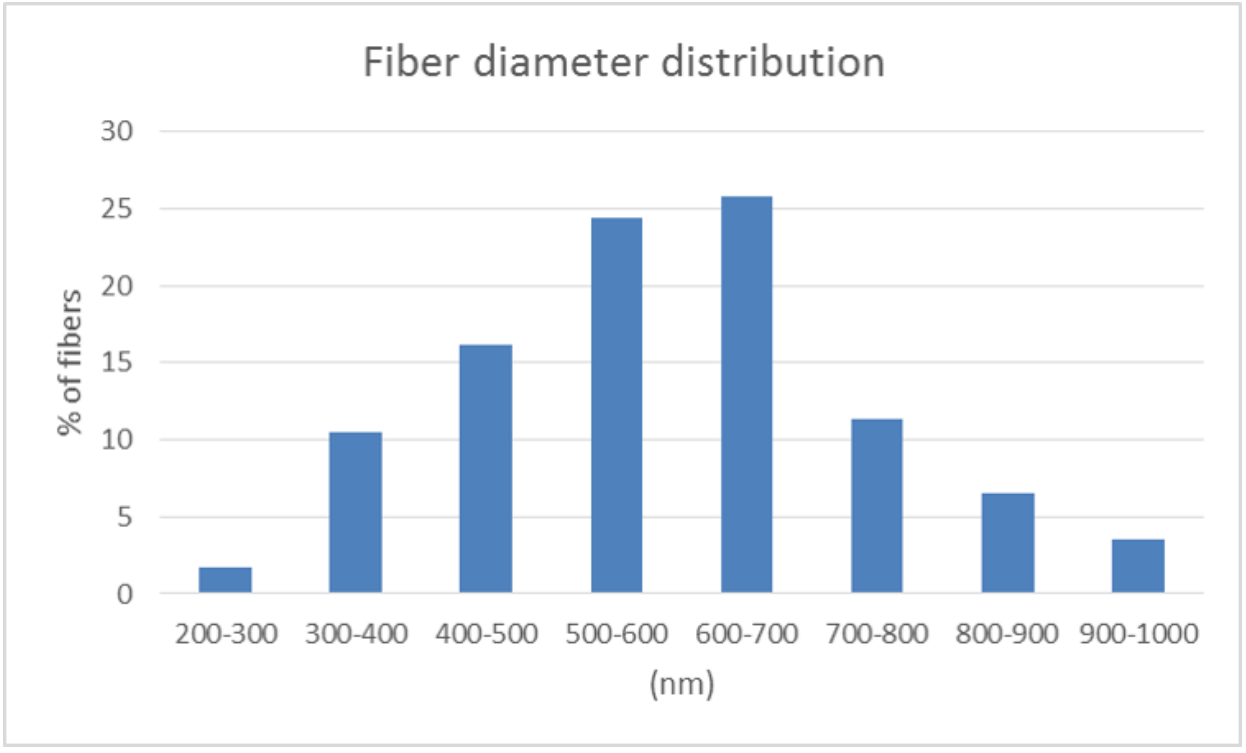




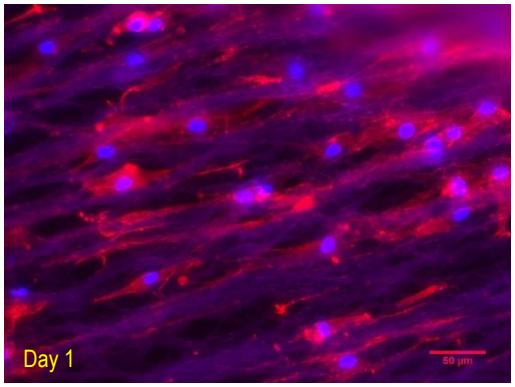


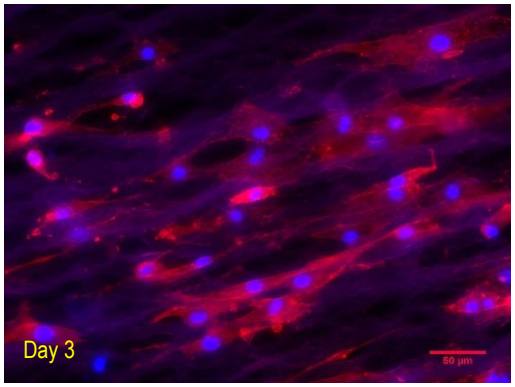
Glycomer™ 631: 100 mg/ml

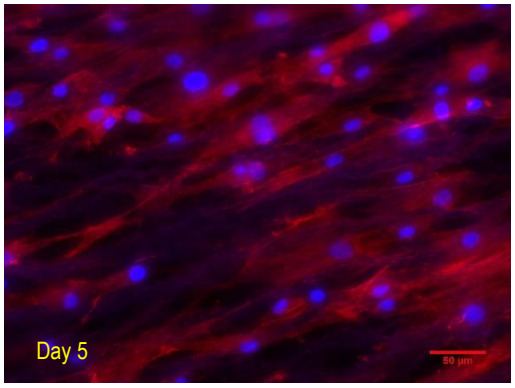
>90 % alignment

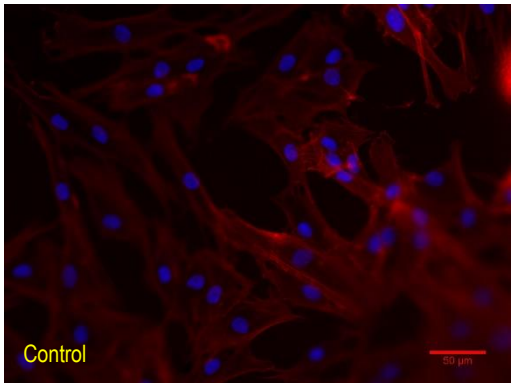


Tenocyte response to Glycomer™ 631 nanofibrous scaffolds

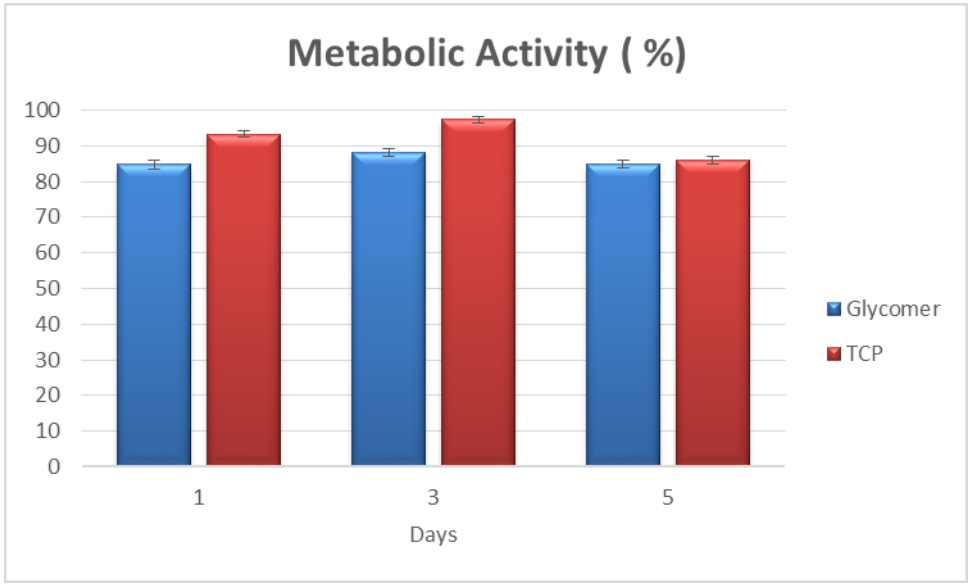






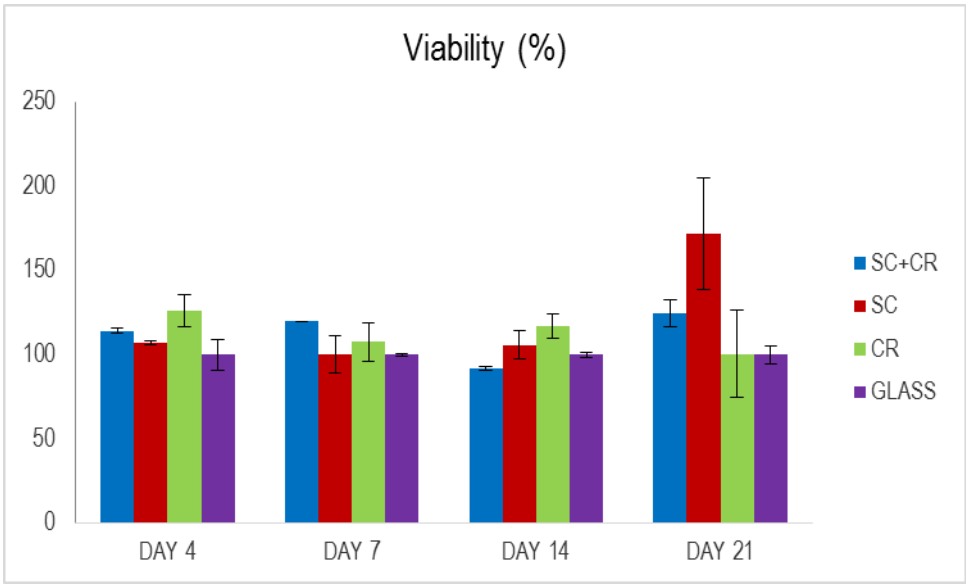


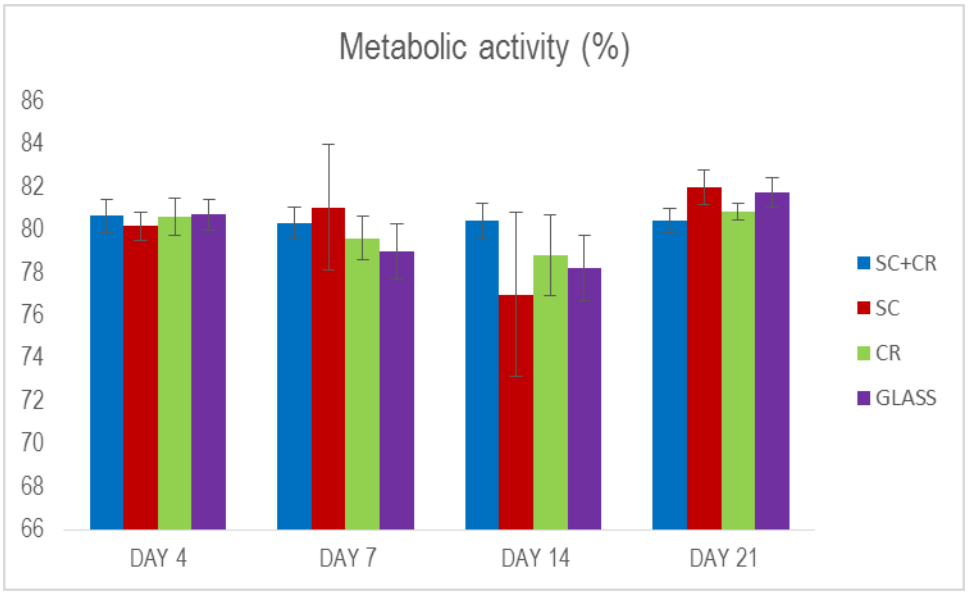
DAPI:rhodamine



Human Tenocytes, P: 4 (3000/cm^2),

Glycomer™ 631 and CR maintain tenocyte viability and metabolic activity





Conclusions

A. Glycomer™ 631 can yield a highly aligned nanofibrous scaffold with electrospinning technology

B. Tenocytes acquire elongated – spindle shape on Glycomer™ 631

C. Tenocytes remain viable and metabolically active on Glycomer™ 631 in the presence of Carrageenan after 21 days in culture

Future perspectives

A. Assessment of tendon specific protein secretion
B. Assessment of tendon gene expression
C. Mechanical characterisation of the scaffold

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Mr Dilip Thomas

Mr Maciek Doczyk

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