دانشکده علوم نوین پزشکی
دپارتمان نانوفناوری پزشکی

Complex tissue engineering of vessels structure using PU-PCL nano-scaffold by engaging endothelial lineage and Smooth muscle cells

دانشکده علوم نوین پزشکی

دپارتمان نانوفناوری پزشکی

Thesis submitted for the award of Doctor of Philosophy (PhD)

Presenter :

S. Fathi

Supervisor:

Prof. S. Davaran

Dr. R. Rahbar ghazi

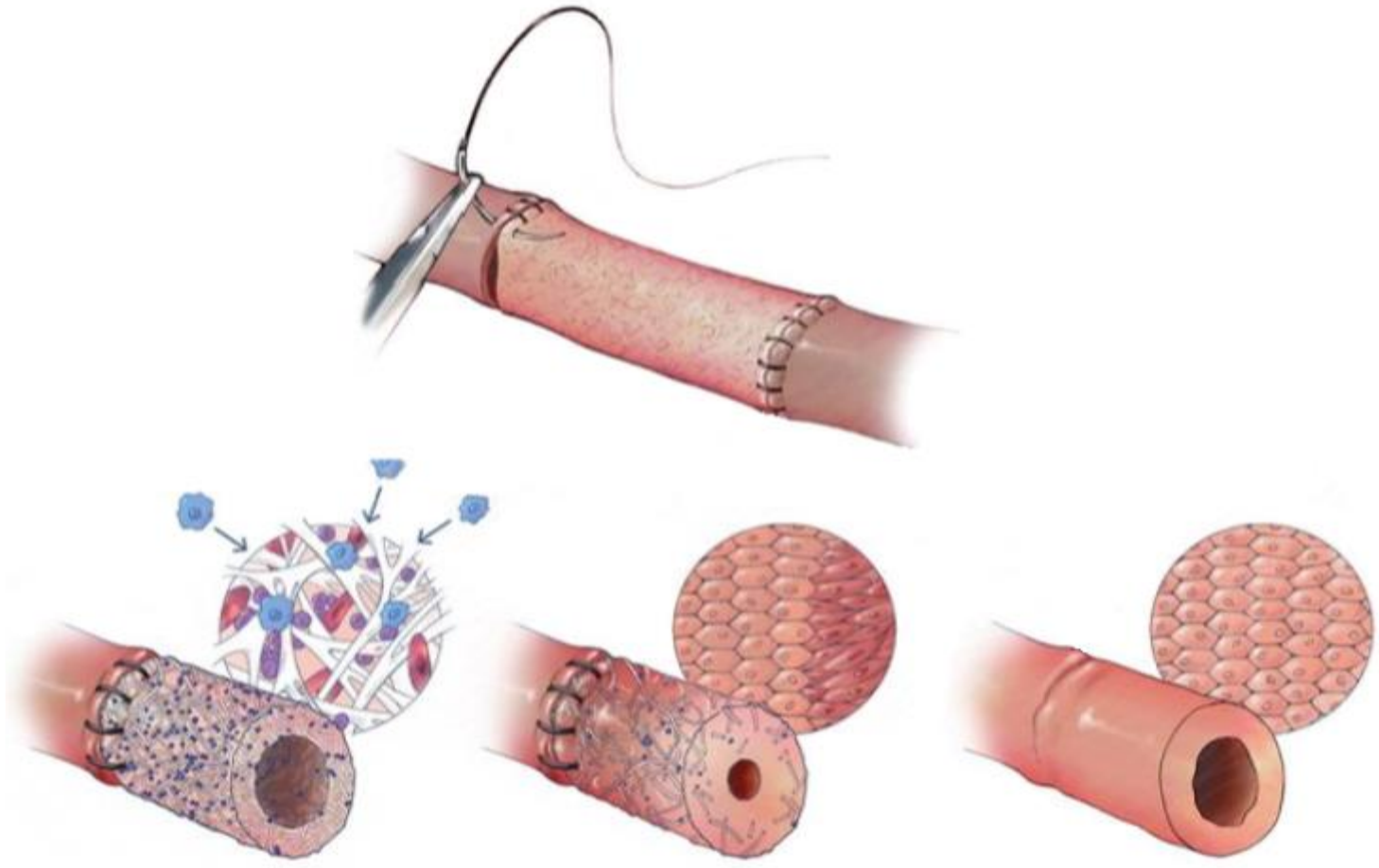
Prof. A. Seifalian

Advisors:

Dr. R. Salehi

Dr. A. Akbarzadeh

July 2020

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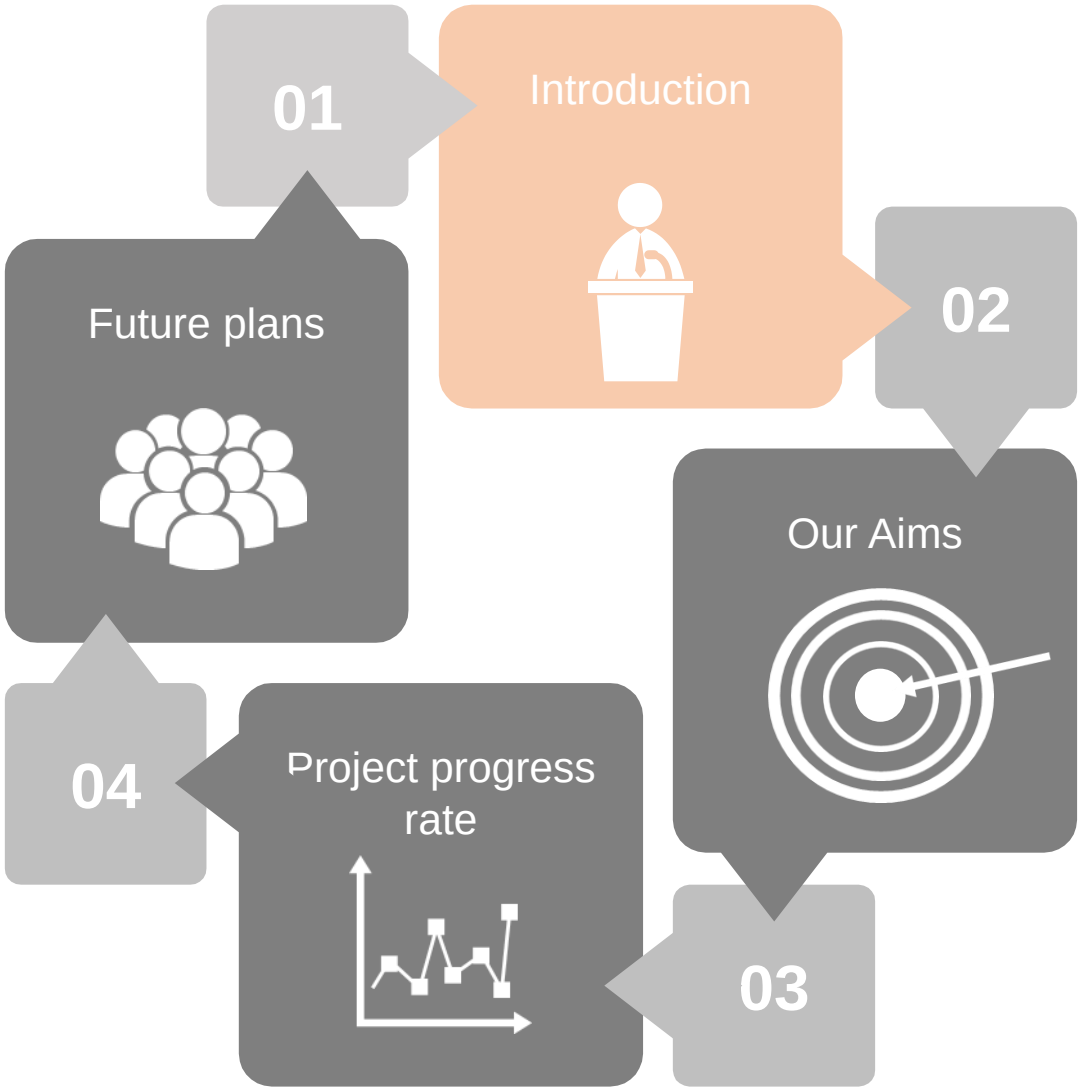
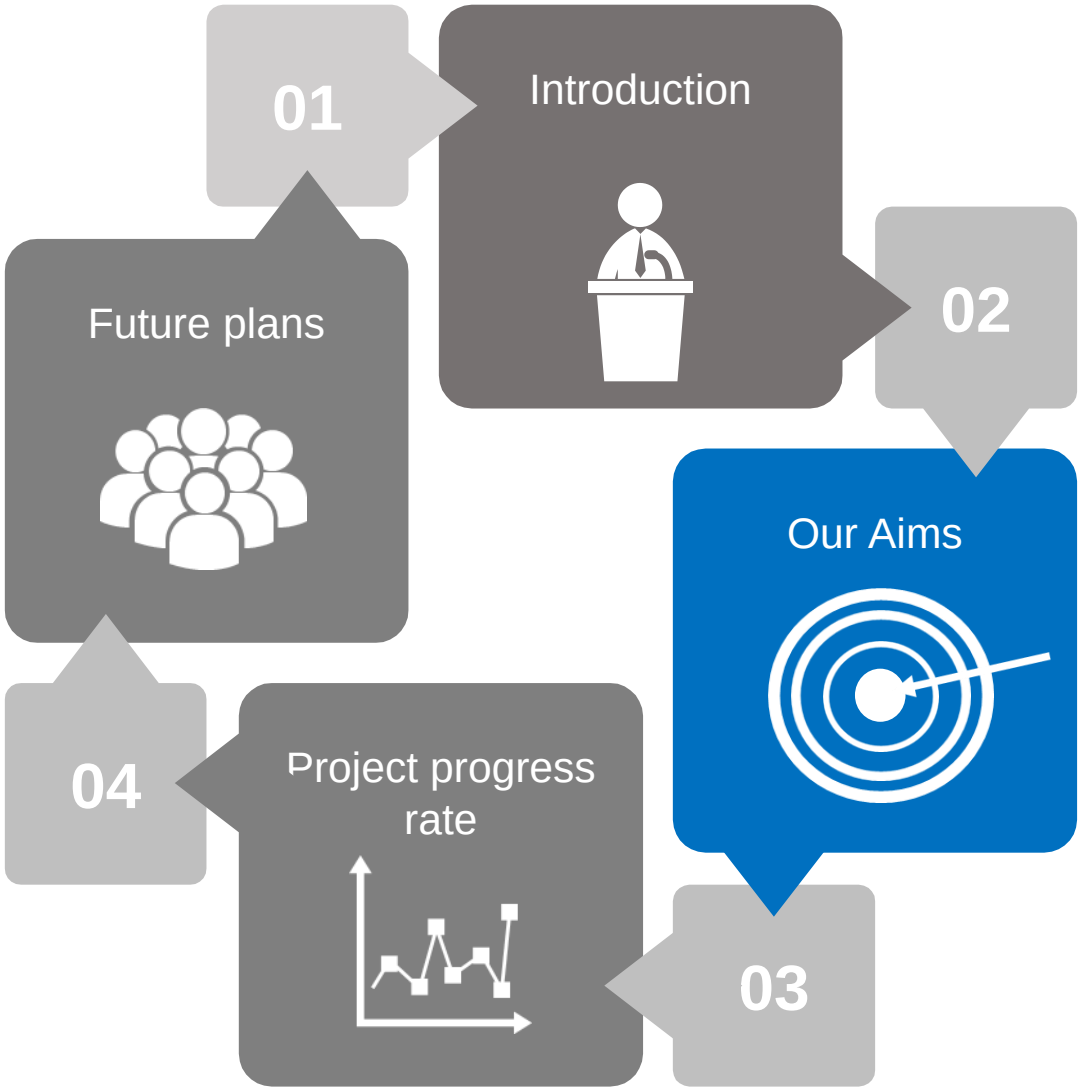


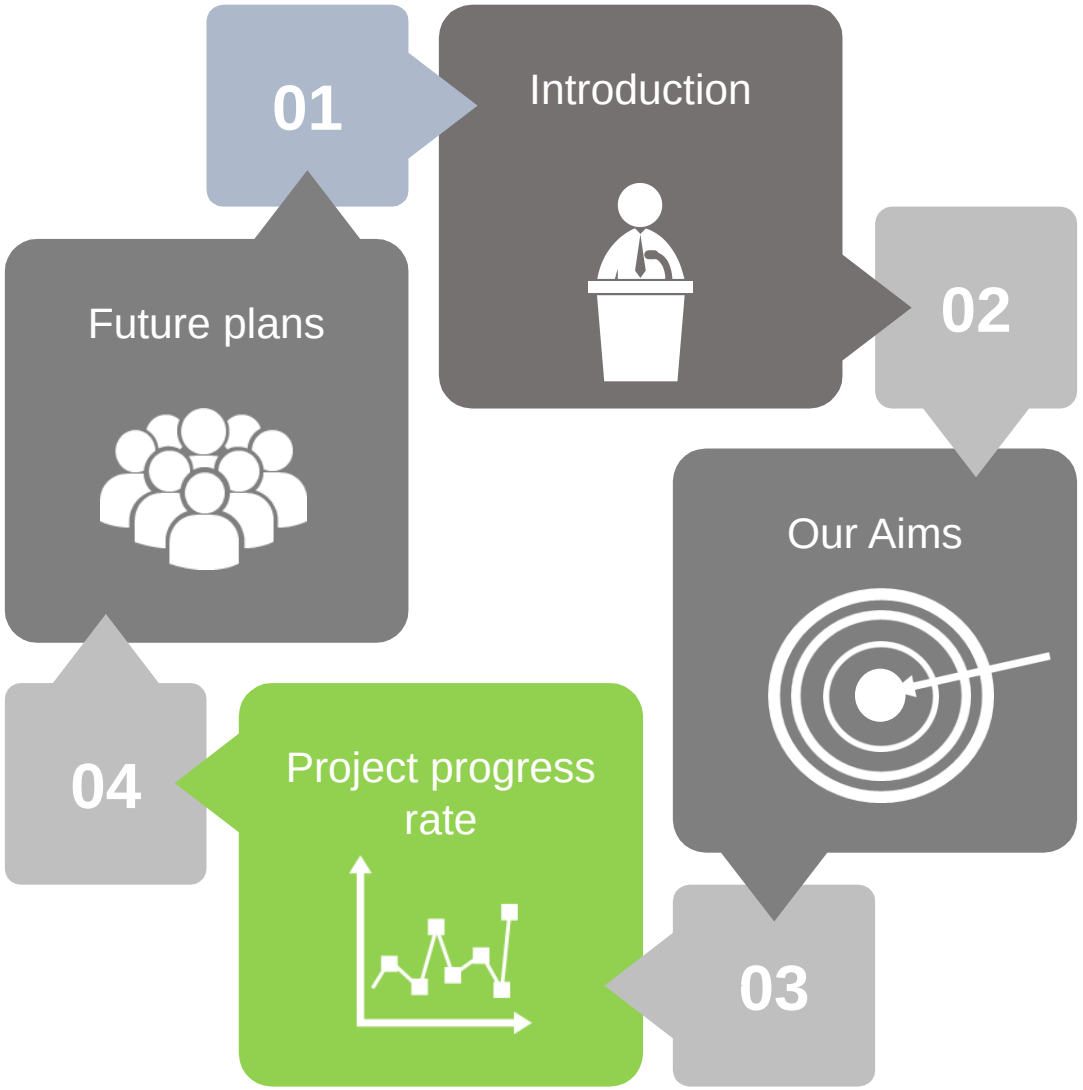
Introduction

- Cardiovascular diseases are the leading cause of mortality around the globe.
- Vascular tissue engineering has significant potential to make a major impact on a wide array of clinical problems.
- In 1912, Carrel was the first to describe the use of glass or metal tubes to bypass arterial defects in dogs
- PTFE, PET, PVC, PCL-Collagen, Collagen-elastin
- PU & PCL



Our Aims

- Preparation and characterizations of PU-PCL nanofibers
- Seeding of ECs on scaffolds and evaluation of in vitro cell culture
- Preparation and characterizations of PU-PCL tubular structure
- Bioreactor design
- Seeding of ECs on tubular scaffolds in dynamic condition
- Heparinizing prepared scaffolds
- Seeding and characterizations of Ecs and Mesenchymal Stem Cells and Differentiation to Pericyte Cells

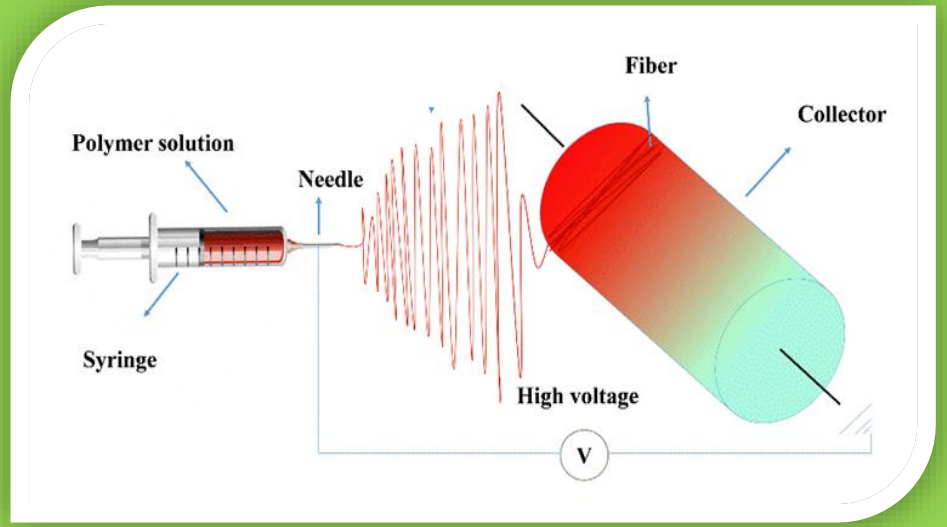


Project progress rate

- ✓ Preparation and characterizations of PU-PCL nanofibers (SEM analysis, ATR-FTIR, Contact angle measurement, Tensile strength, Swelling analysis and hydrolytic degradation).
- ✓ Seeding of ECs on scaffolds and evaluation of in vitro cell culture (MTT assay and Measuring NO)
- ✓ Preparation and characterizations of PU-PCL tubular structure
- ✓ Bioreactor design
- ✓ Seeding of ECs on tubular scaffolds in dynamic condition
- ✓ Published articles!

Preparation and characterizations of PU-PCL nanofibers

polymeric solutions were allocated into five separate groups as follows (PU, PU/PCL(2:1), PU/PCL(1:1), PU/PCL(1:2) and, PCL)



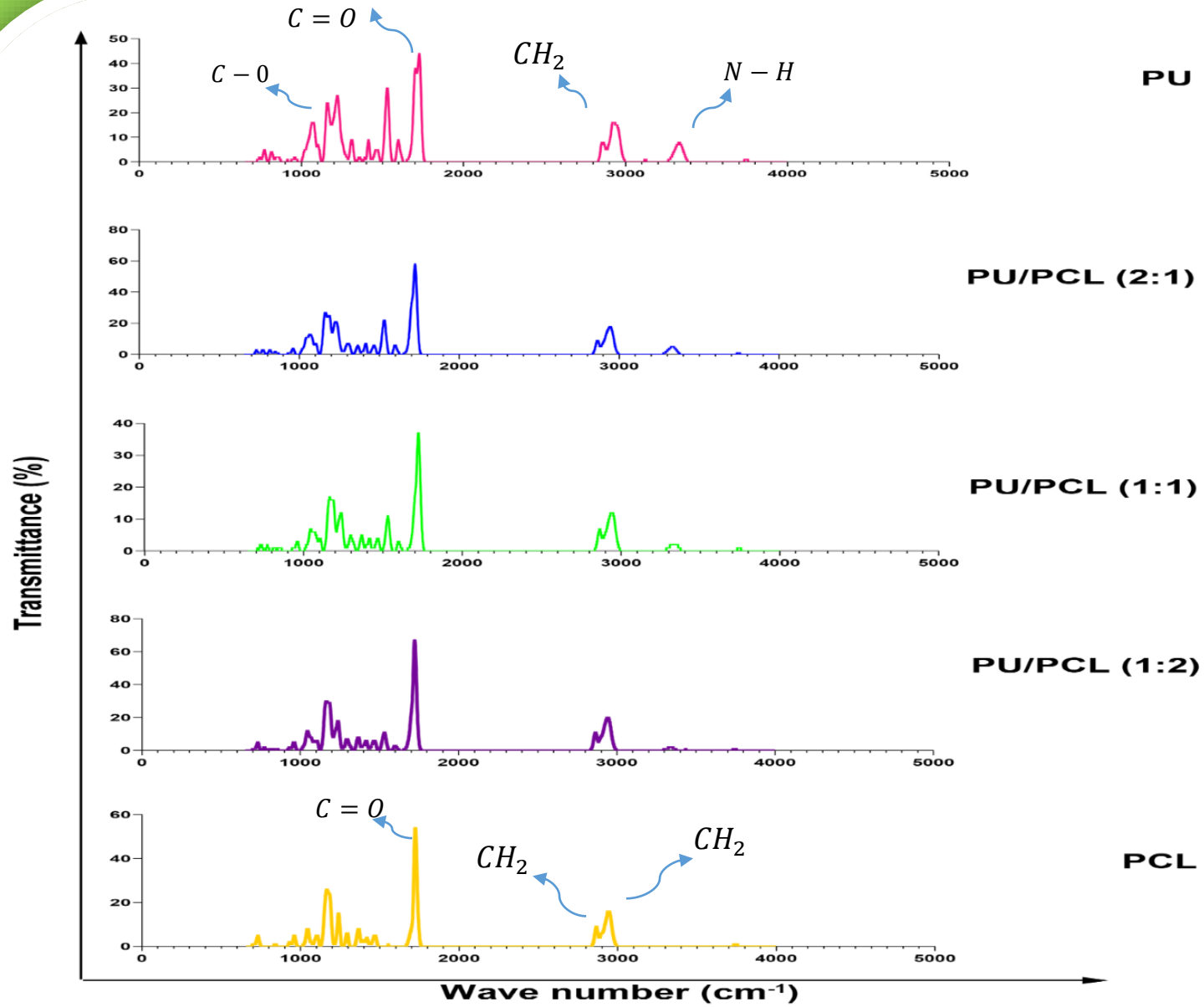
ATR-FTIR **Tensile strength**

Swelling analysis & Contact angle measurement

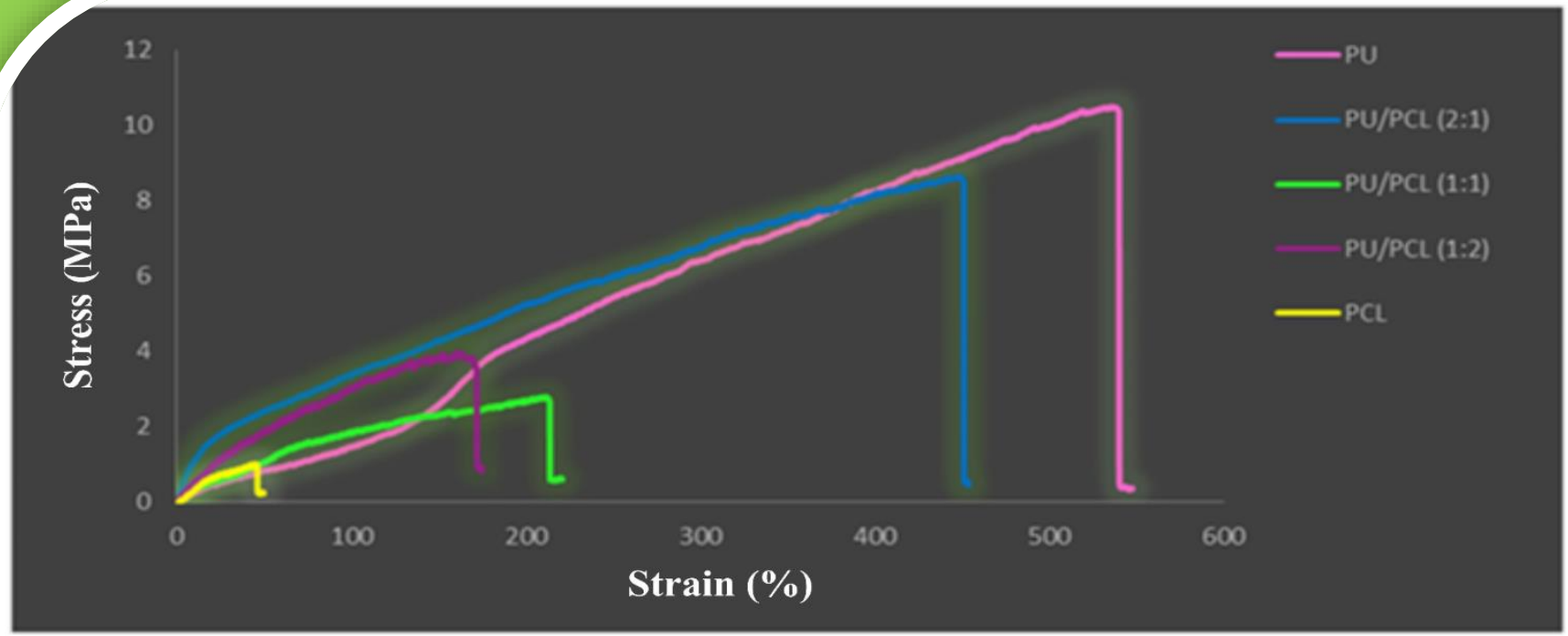
hydrolytic degradation

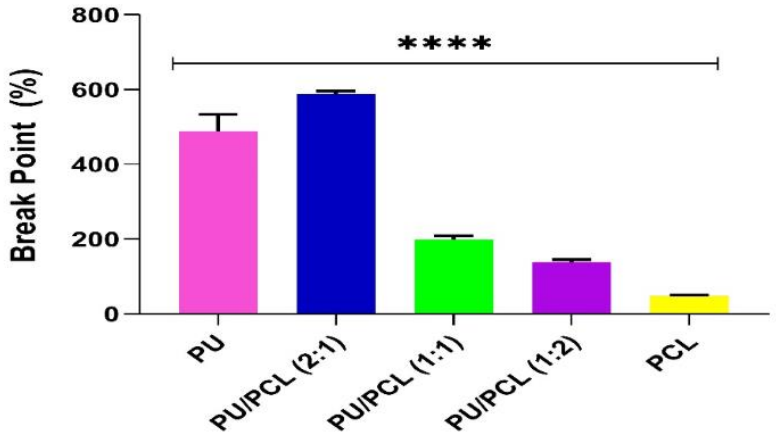
SEM analysis

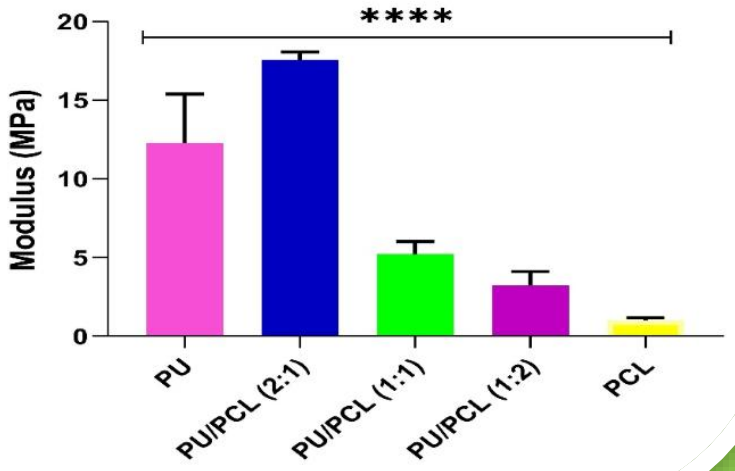
ATR-FTIR


C = O
C − 0
CH2
N − H
PU
PU/PCL (2:1)
PU/PCL (1:1)
PU/PCL (1:2)
C = O
CH2
CH2
PCL
Transmittance (%)
Wave number (cm-1)

Tensile strength

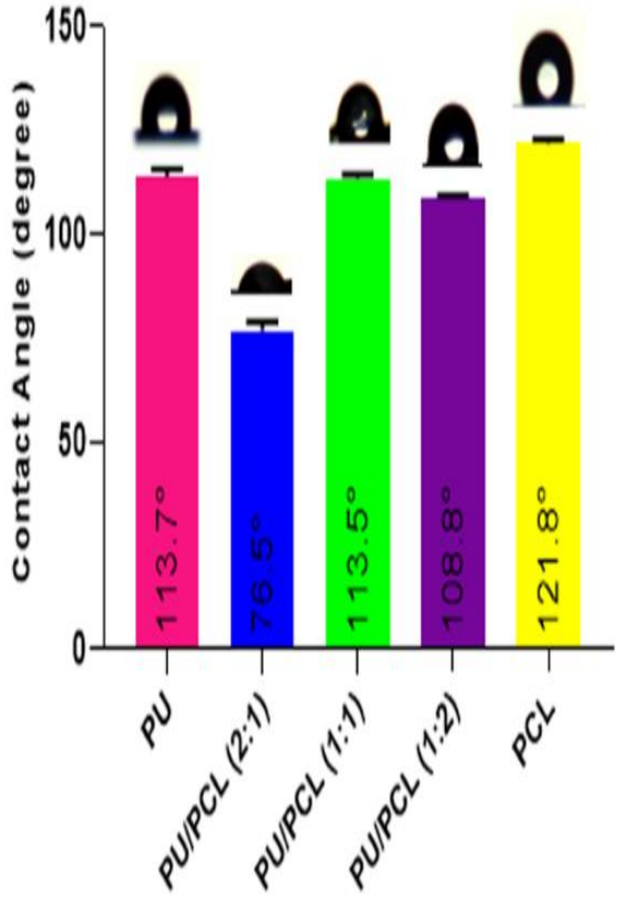






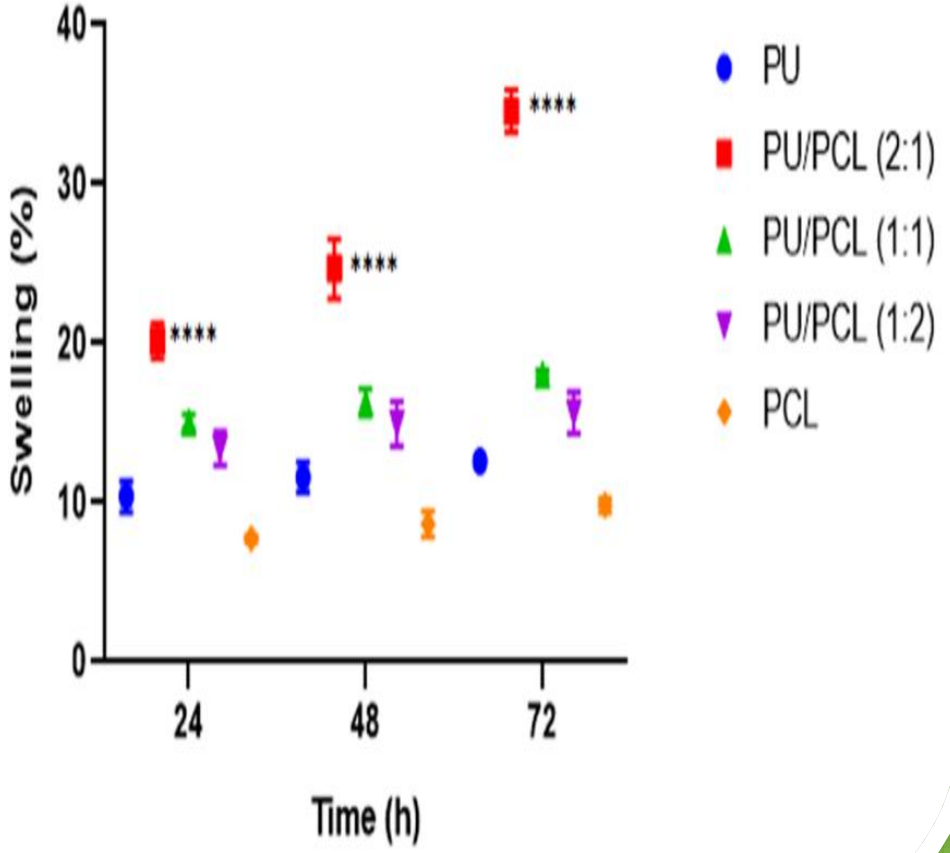
Swelling analysis & Contact angle measurement

A



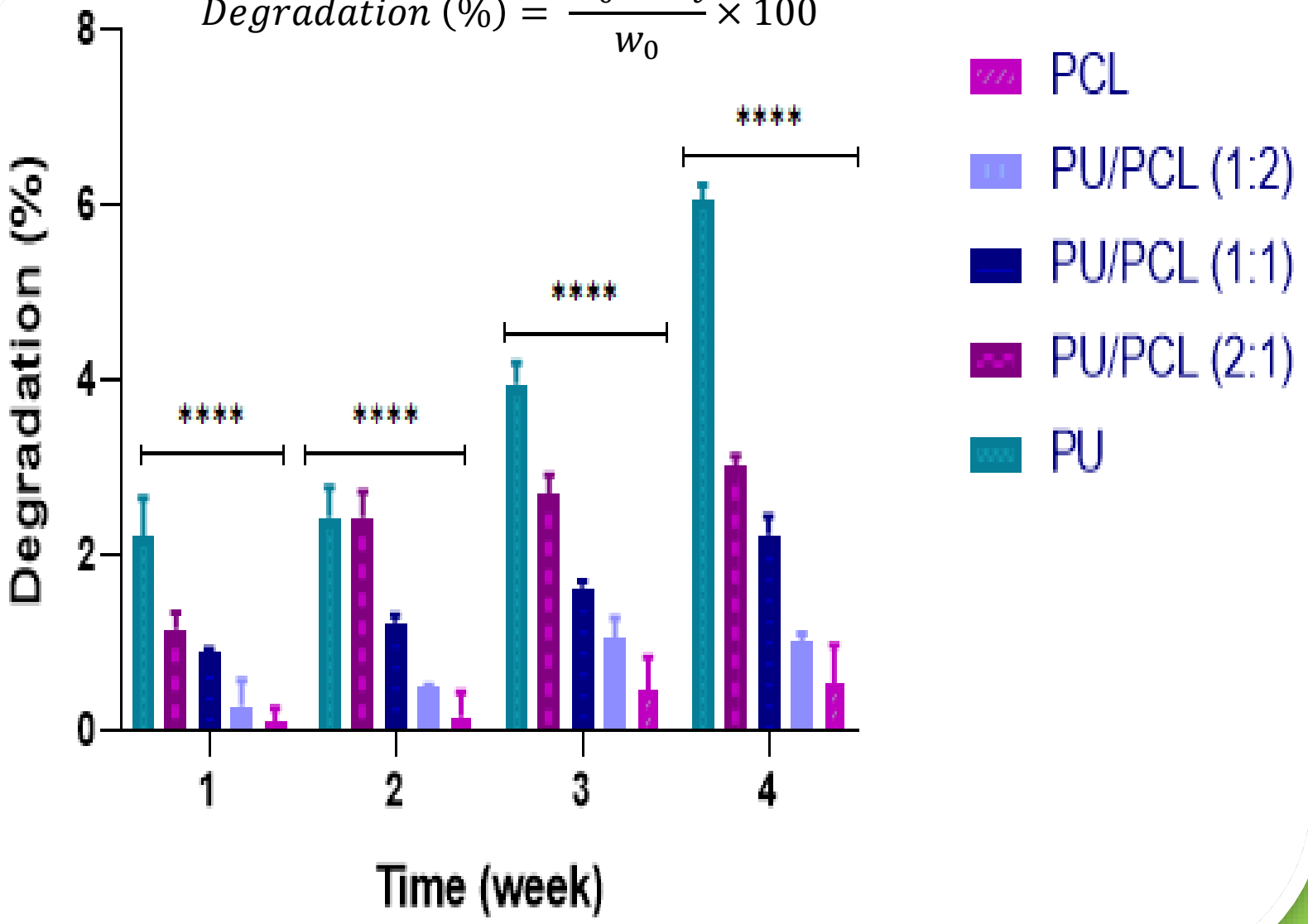
B

$$\%S = \frac{W_s - W_d}{W_d} \times 100$$

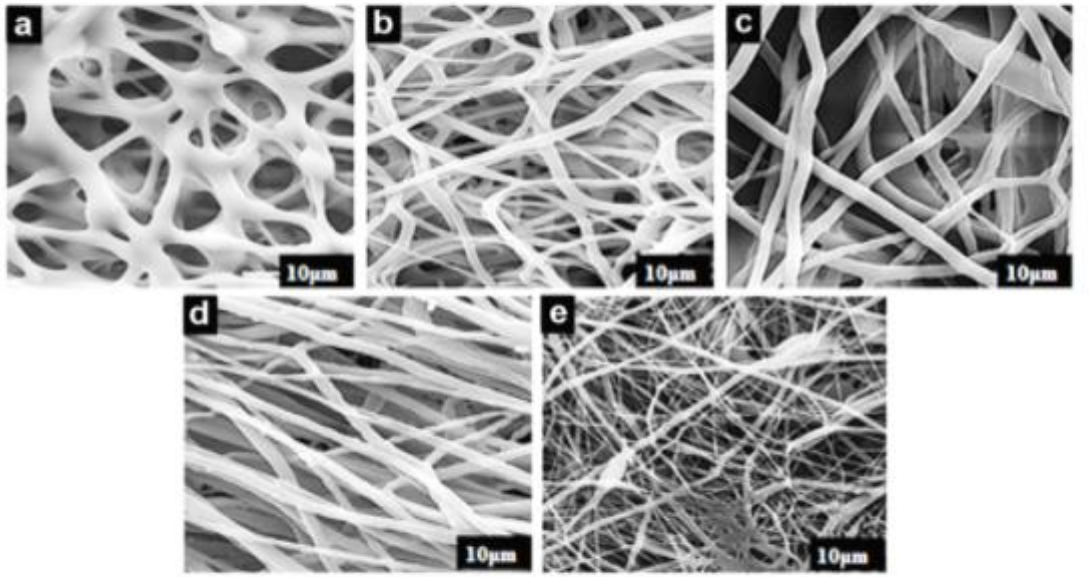


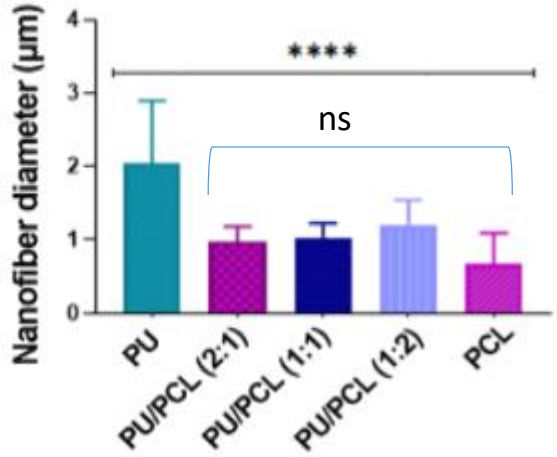
hydrolytic degradation

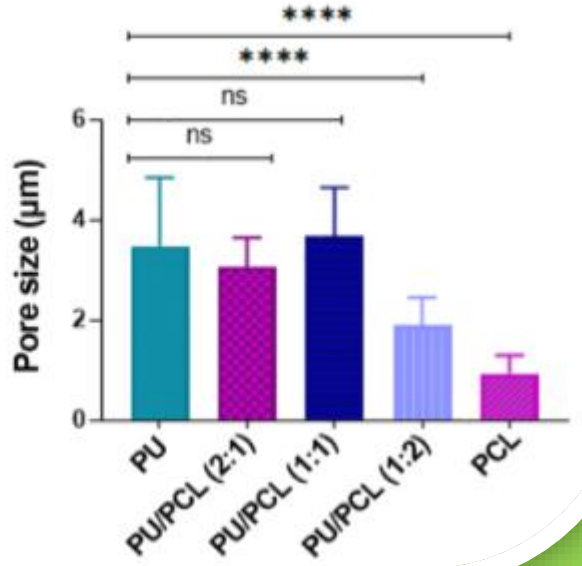
$$Degradation\ (\%) = \frac{w_0 - w_t}{w_0} \times 100$$



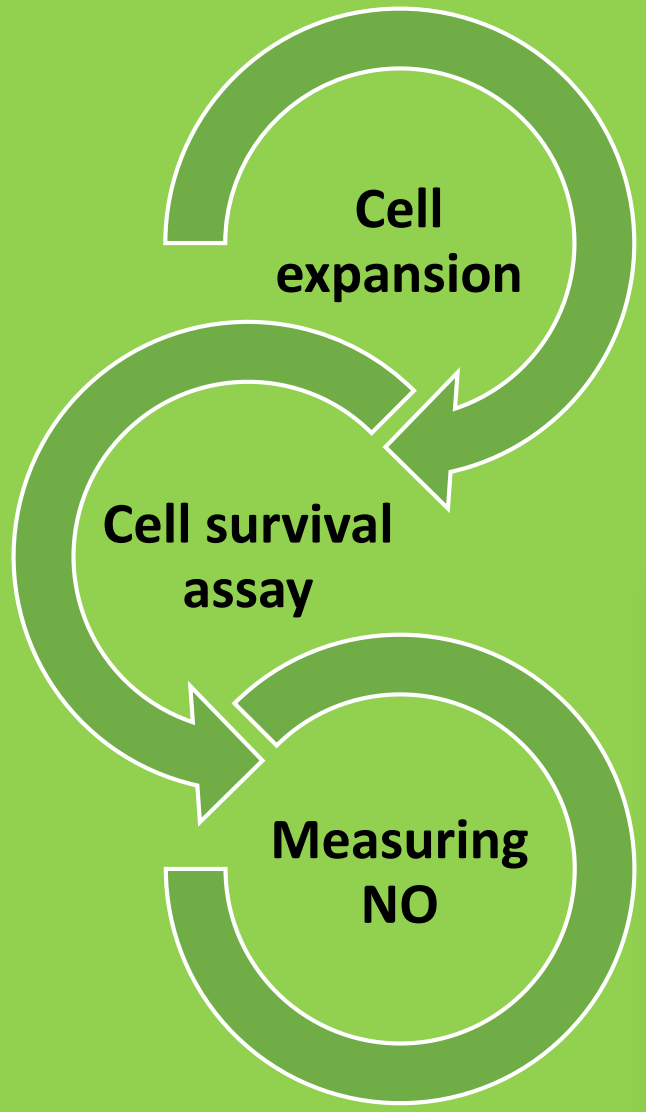
SEM analysis

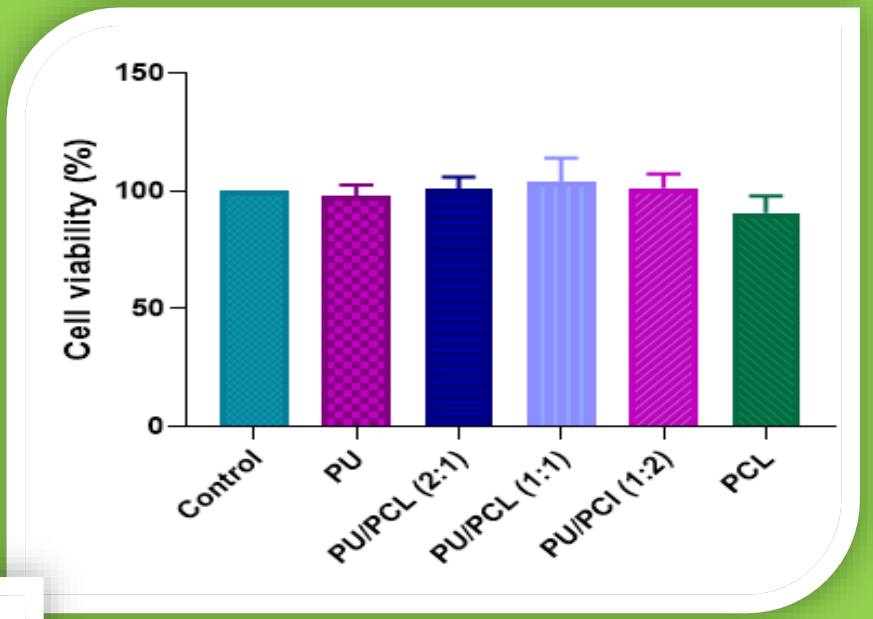


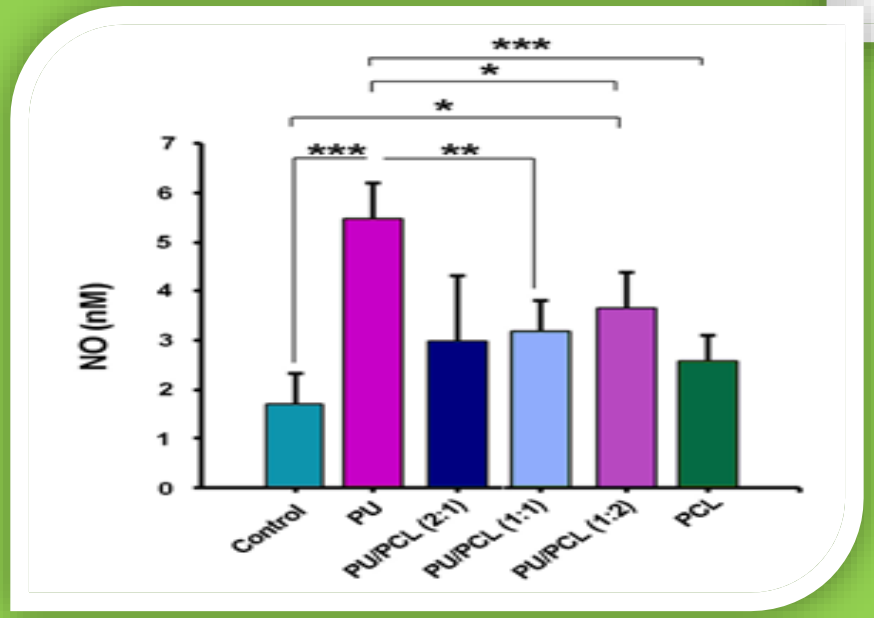




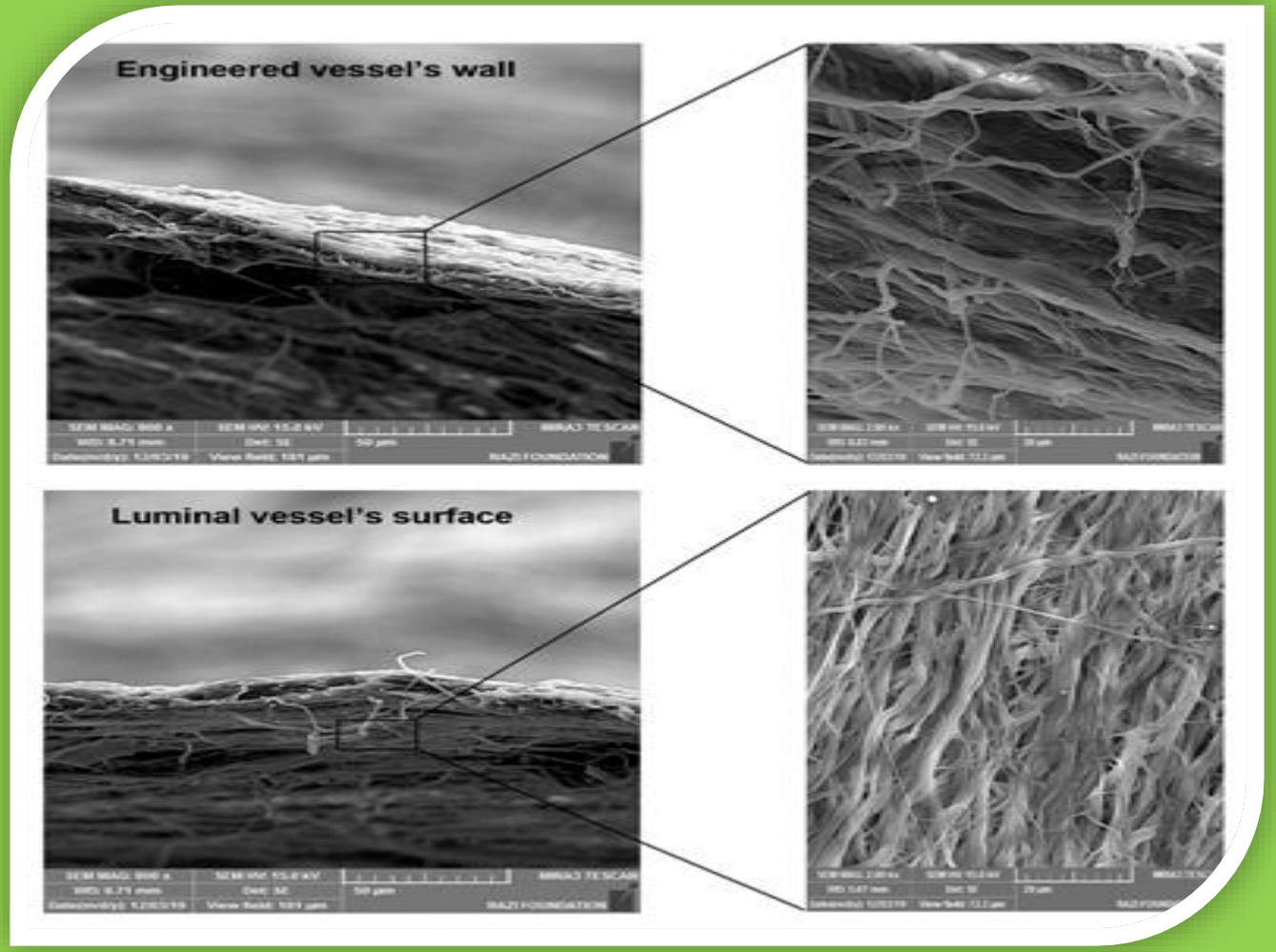
Seeding of ECs on scaffolds and evaluation of in vitro cell culture



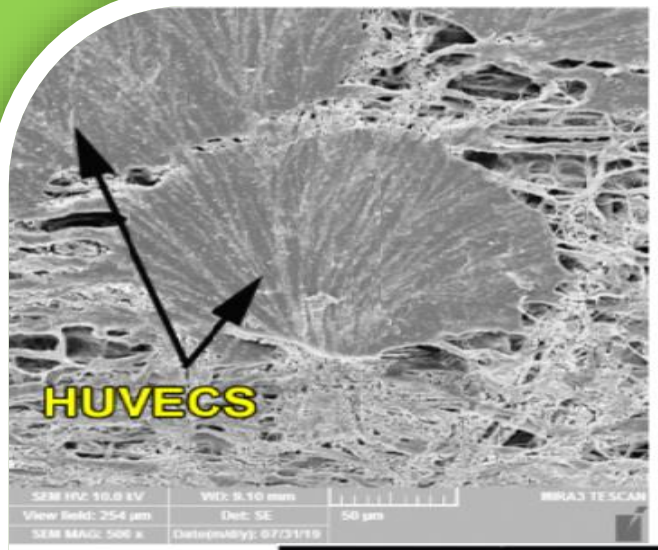


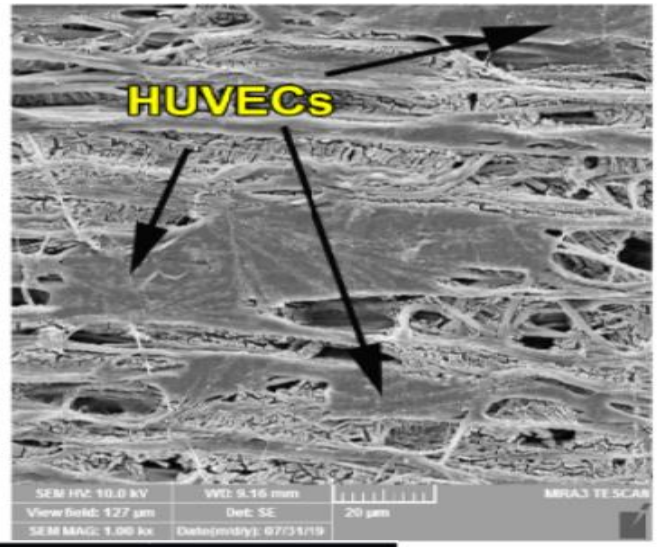


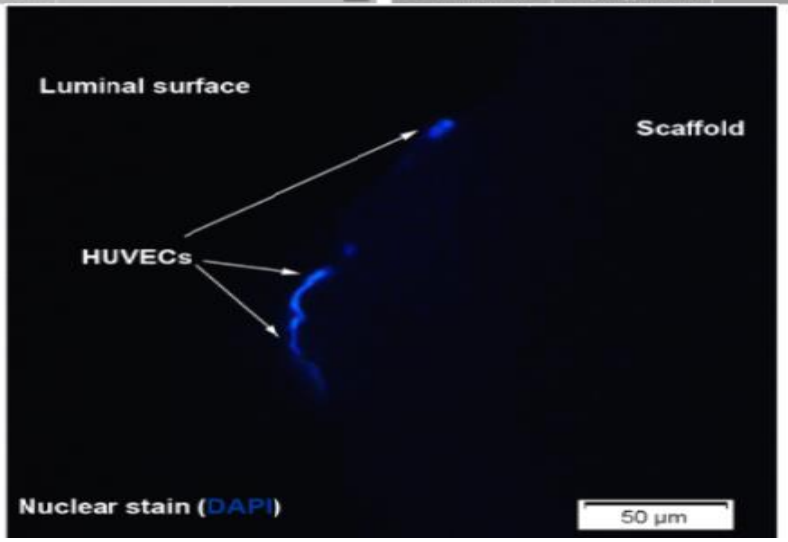
Preparation and characterizations of PU-PCL tubular structure

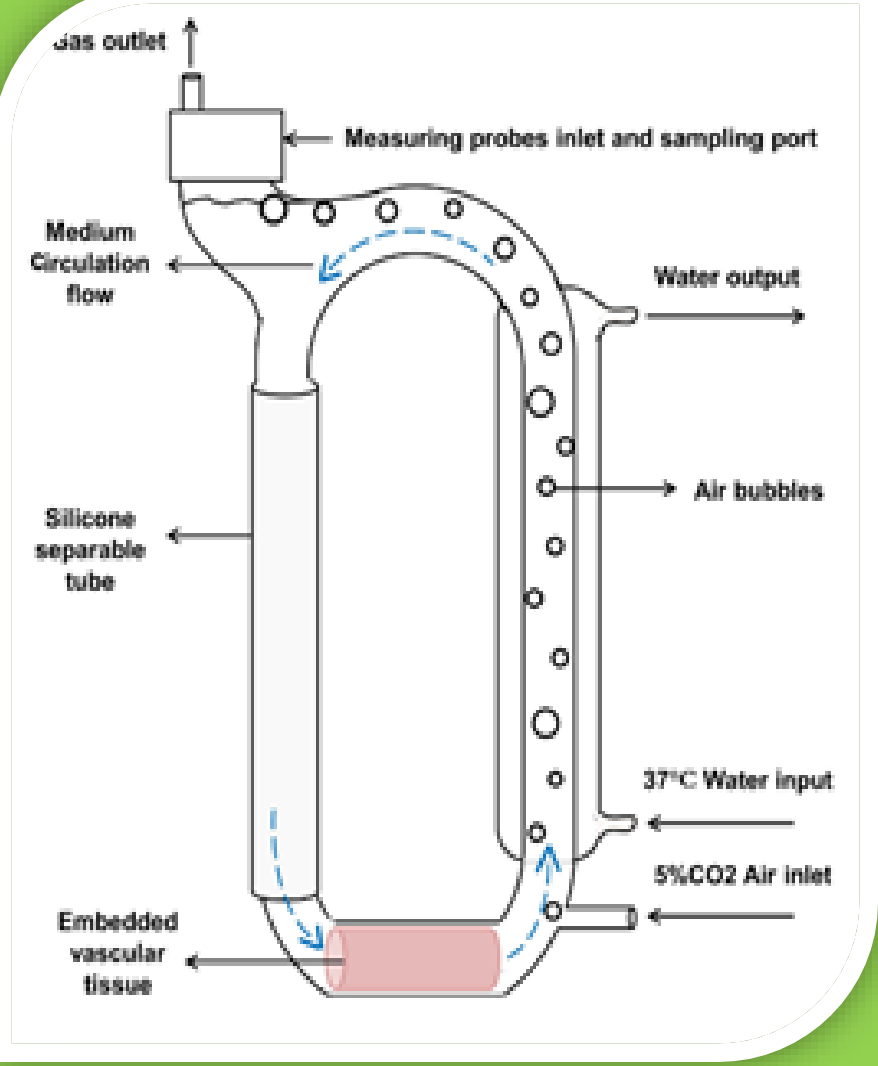


Bioreactor design and cell culture









Published articles

...an et al. Journal of Biological Engineering (2019) 13:83
https://doi.org/10.1186/s13036-019-0199-7

Journal of Biological Engineering

ibe Advancing Biology-Inspired Engineering
Official publication of the Institute of Biological Engineering

REVIEW Open Access

Electrospun nanofibers for the fabrication of engineered vascular grafts

Sonia Fathi Karkan[1,2,3], Soodabeh Davaran[1*†], Reza Rahbarghazi[4,5*†], Roya Salehi[1,2] and Abolfazl Akbarzadeh[6]

Abstract

Attention has recently increased in the application of electrospun fibers because of their putative capability to create nanoscale platforms toward tissue engineering. To some extent, electrospun fibers are applicable to the extracellular matrix by providing a three-dimensional microenvironment in which cells could easily acquire definite functional shape and maintain the cell-to-cell connection. It is noteworthy to declare that placement in different electrospun substrates with appropriate physicochemical properties enables cells to promote their bioactivities, dynamics growth and differentiation, leading to suitable restorative effects. This review paper aims to highlight the application of biomaterials in engineered vascular grafts by using electrospun nanofibers to promote angiogenesis and neovascularization

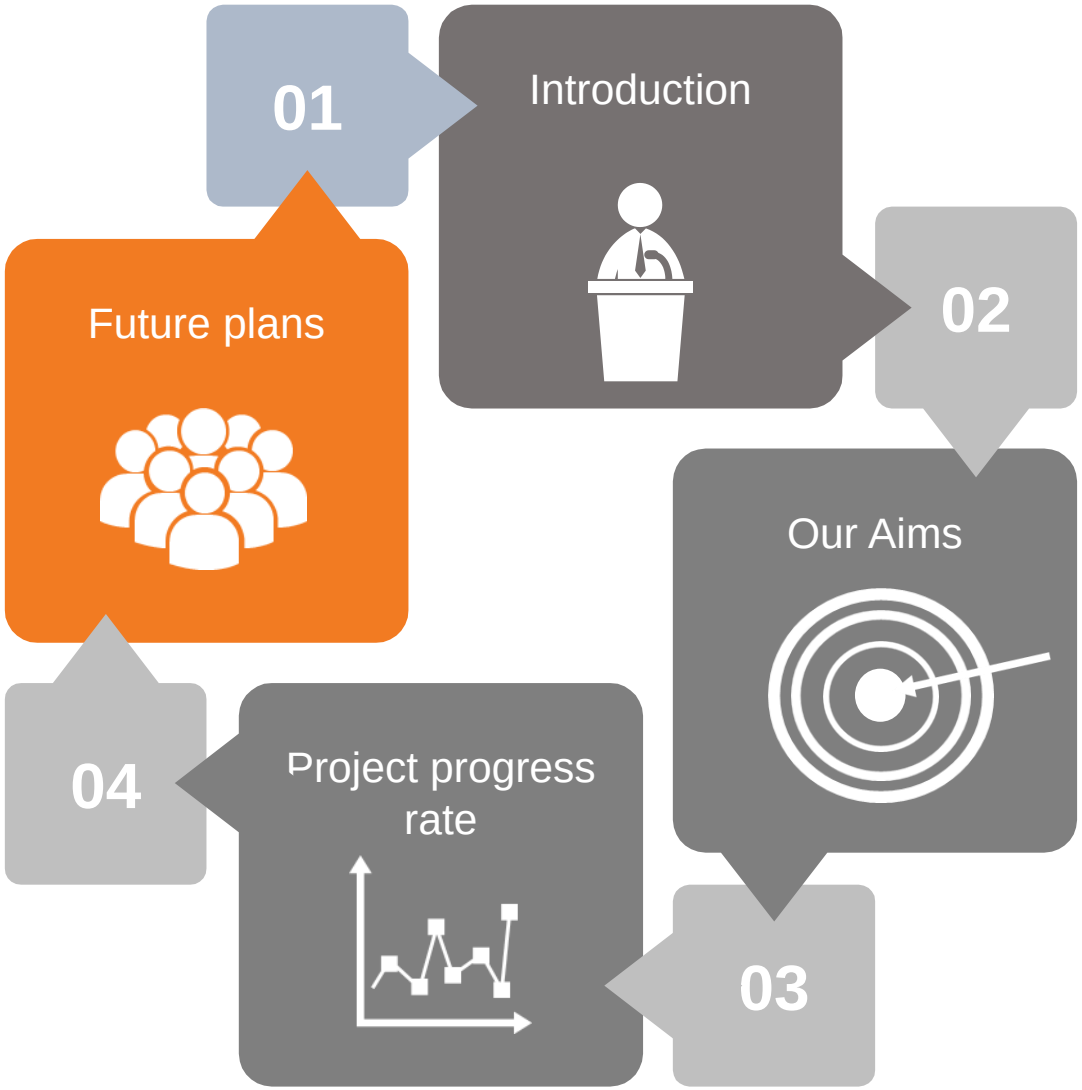
Keywords: Electrospun nanofibers, Engineered vascular grafts, Angiogenesis, Regenerative medicine

Microvascular Research

Electrospun polyurethane/poly (ε-caprolactone) nanofibers promoted the angiogenic potential of human endothelial cells in static and dynamic conditions

--Manuscript Draft--

Manuscript Number:	MVR-D-20-00094
Article Type:	Research Paper
Keywords:	PU/PCL scaffold; Human Umbilical Vein Endothelial Cells; Engineered Vascular Tissue; Angiogenic Capacity; Static and dynamic Culture
Corresponding Author:	Reza Rahbarghazi Tabriz University of Medical Sciences, Tabriz, Iran Tabriz, IRAN, ISLAMIC REPUBLIC OF
First Author:	Sonia Fathi Karkan
Order of Authors:	Sonia Fathi Karkan
	Reza Rahbarghazi
	Soodabeh Davaran
	Leila Shafiei Kaleybar
	Ali Baradar Khoshfetrat
	Morteza Heidarzadeh
	Elmira Zolali
	Abolfazl Akbarzadeh
Abstract:	In this study, the angiogenic capacity of human endothelial cells was examined on polyurethane-poly caprolactone (PU/PCL) scaffolds after 72 hours. Cells were designated into five different groups, including PU, PU/PCL (2:1), PU/PCL (1:1); PU/PCL (1:2); and PCL. Data revealed that the PU/PCL (2:1) composition had proper mechanical properties, such as stress/strain, contact angle and swelling rate, compared to the other groups ($p<0.05$). It found that PU/PCL (2:1) had appropriat



Future plans

- Heparinizing prepared scaffolds
- Seeding and characterizations of Ecs and Mesenchymal Stem Cells and Differentiation to Pericyte Cells

Thank you for your kind attention!

Hope for a better future