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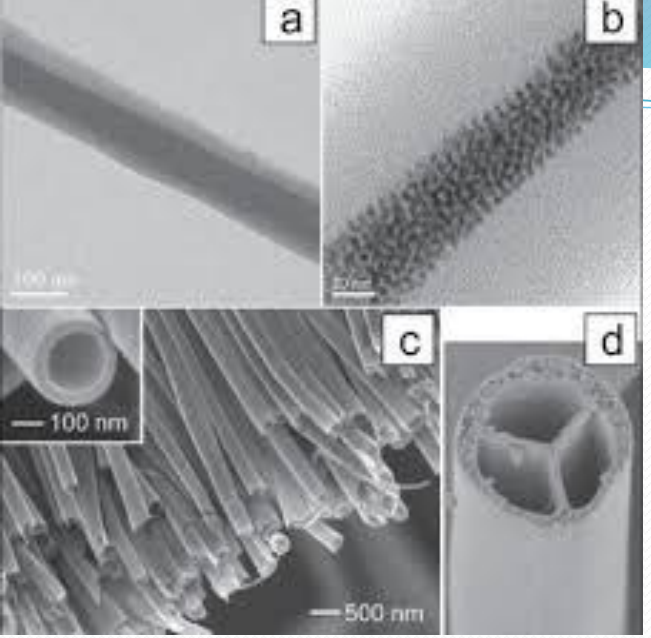

Core shell structure of Nanofiber Scaffold in Neural Regeneration

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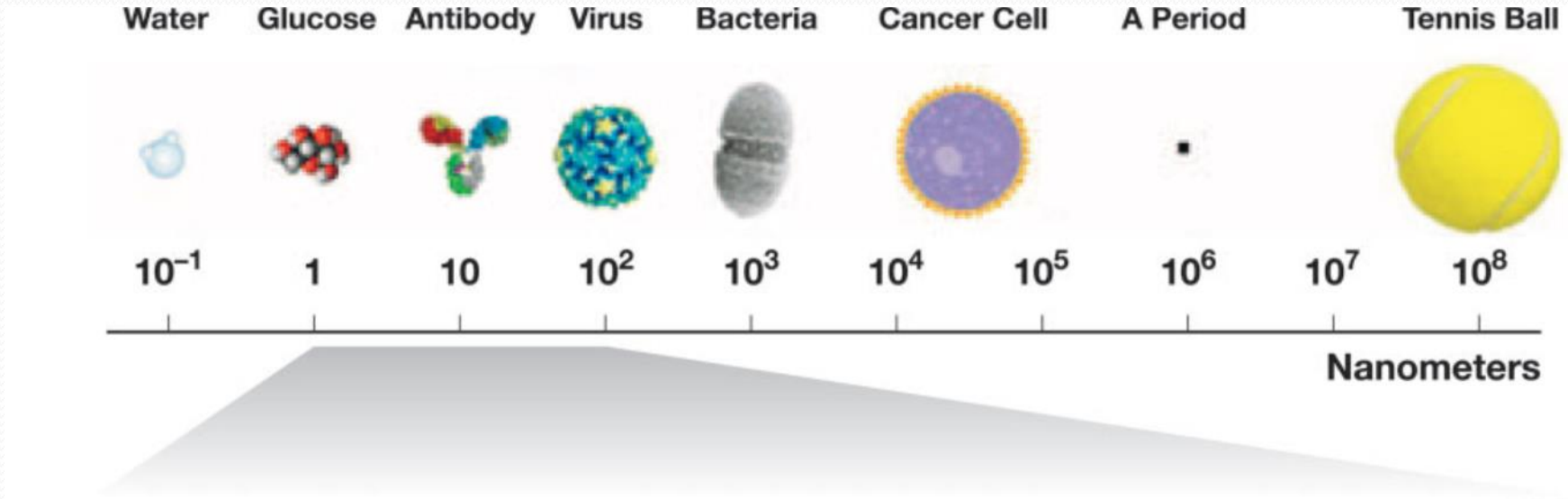
Nanotechnology Definition

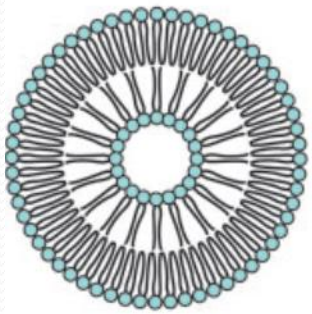
❑ Nanoscience :

- The study of phenomena
- The manipulation of materials
  At atomic, molecular and macromolecular scales

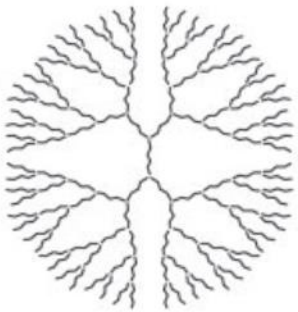
❑ Nanotechnology

- The design and production of structures, devices and systems
- Applications of their at the nanometre scale

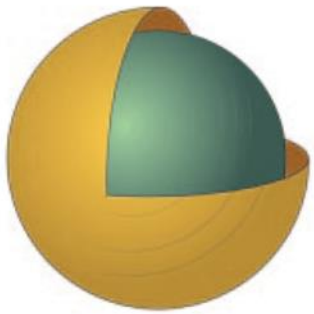




Liposome



Dendrimer



Gold Nanoshell

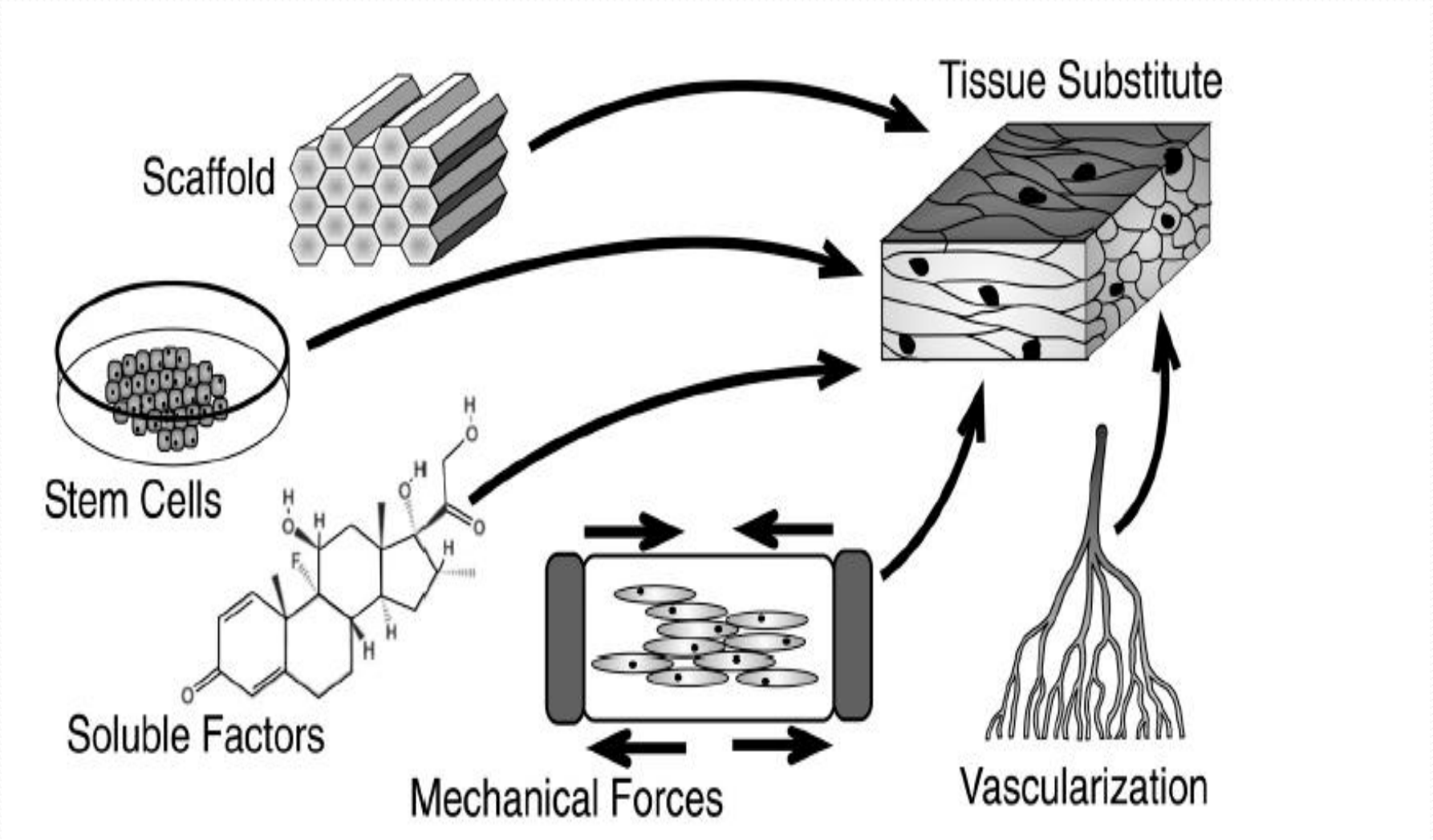
Quantum Dot

Fullerene

Application in Stem Cell Biology

- Cell Microenvironment
- Cell Transfection
- Isolation and Sorting
- Tissue Engineering
- Tracking and Imaging
- Molecular Detection

Tissue Engineering

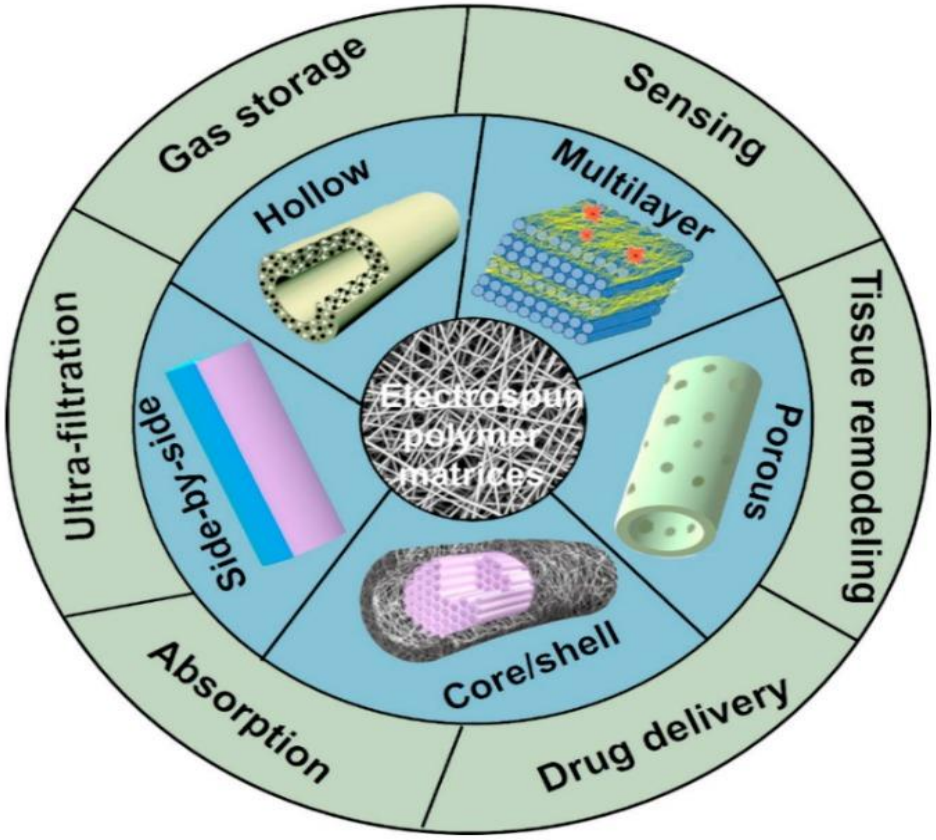


Nanofibrous Scaffold

- Adherence, Migration, and expansion of cells with negligible cell apoptosis.

- Prospective vehicle for:

  - ✓ Drug-delivery
  - ✓ Growth factors encapsulation
  - ✓ Biomolecule encapsulation



Principles for Growth Factor Delivery

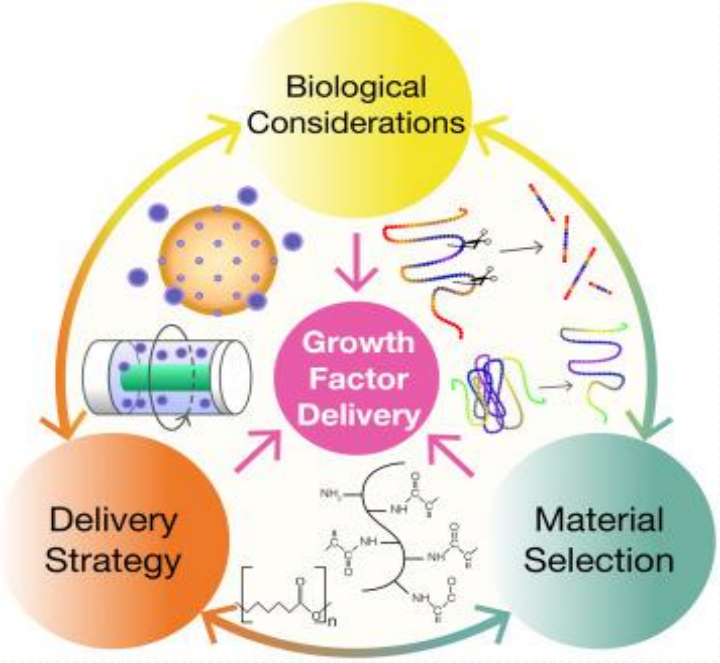
- GF easily lose their activity upon chemical or physical processing

- Stages which the stability of a growth factor incorporated in a scaffold must be preserved:

(1) Scaffold fabrication

(2) Scaffold storage

(3) Scaffold degradation

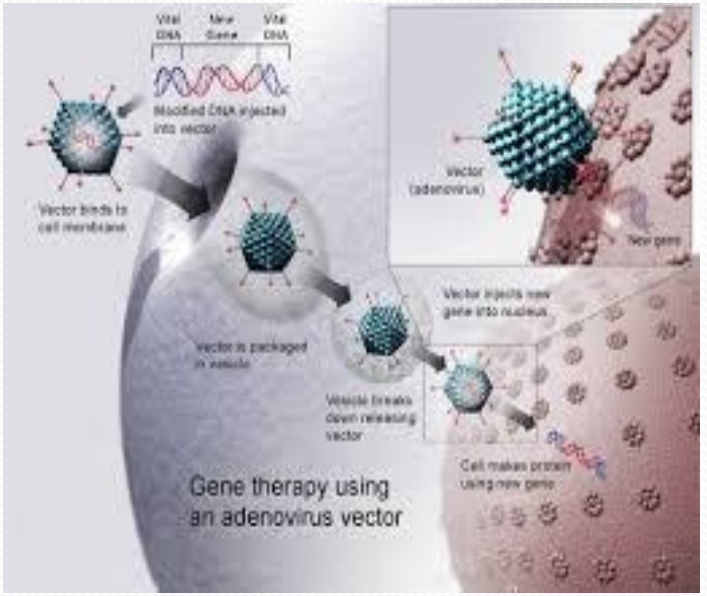


Principles for Gene Delivery

- **A prerequisite for a successful gene delivery:**
  - The active gene can be released from the scaffold
  - Integrated into the host genome

- **To achieve this goal:**
  - The target gene is always packed within vectors
  - Incorporated into the scaffolds

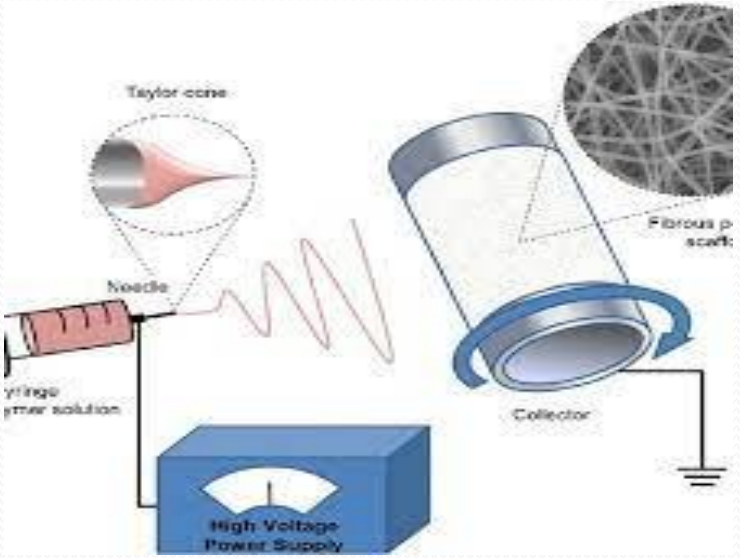
- **Low transfection efficiency:**
  - Low concentration of DNA always results in
  - Much too fast gene release



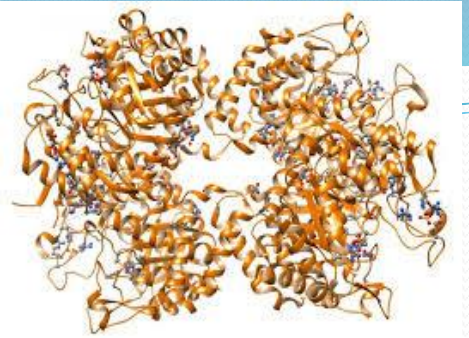
Electrospinning Challenges

Protein instability: **High voltage and contact with organic solvents**

- Low gene transfection efficiency



- Difficulties in release kinetics control



Protein Instability

- **To minimize the interact ion between protein and organic phase:**

1. Coaxial electrospinning

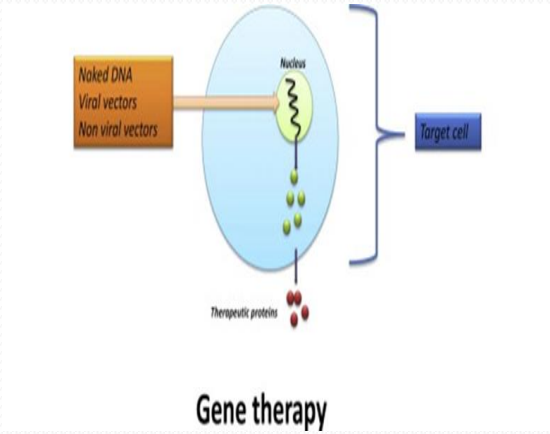
2. Adding hydrophilic additives (e.g., PEG , hydroxyapatite)

3. Protein stabilizer (PEG, dextran, sucrose)

Low Gene Transfection Efficiency

❖ **The low gene transfection efficiency**

1. The poor interactions between released gene particles and cells
2. Low concentrations of released gene



- **To improve gene transfection efficiency:**

➢ Viral vectors seem to be a straightforward option

➢ Nano-scaled delivery carriers, gene gun, disulfide linkages in cationic polymers and bioresponsive polymers

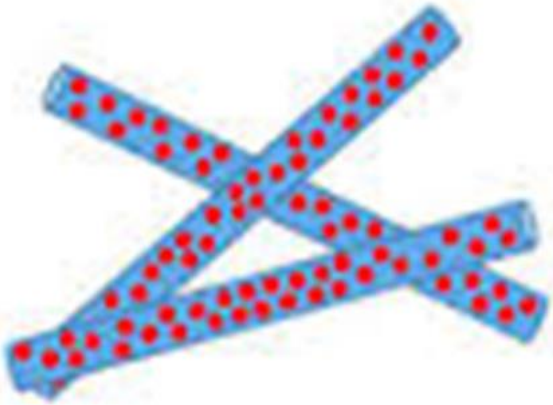
❖ (Difficult to combine with electrospun scaffolds)

Release Control

- Mathematical models to predict release kinetics
- **Factor affected Release kinetics:** Polymer swelling, polymer erosion, biomolecular dissolution/diffusion characteristics, biomolecules distribution inside the matrix, biomolecule/polymer ratio and system
- Degradable polymeric scaffolds: Strongly affected by the surrounding tissue environment (e.g. pH value and cellular tissue reaction)
- No mathematical model available (Release under physiological conditions)
- Necessary to design advanced mathematical models(for in vivo)

Drug Loading Methods

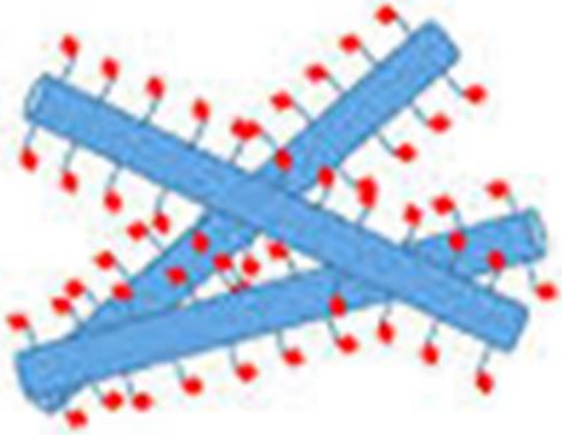
Blend electrospinning



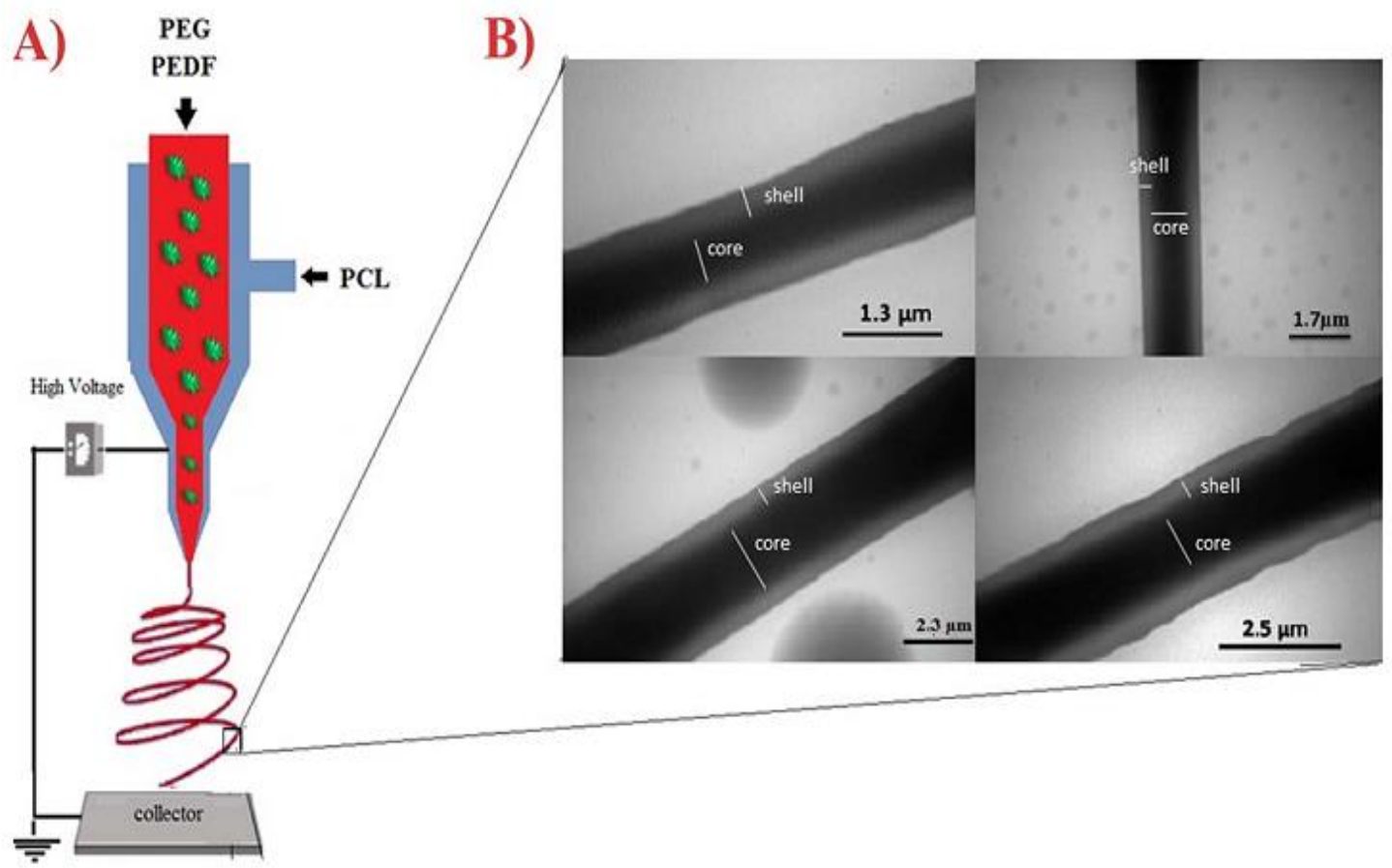
Core-shell electrospinning

Physical adsorption

Chemical immobilization



Coaxial Electrospinning



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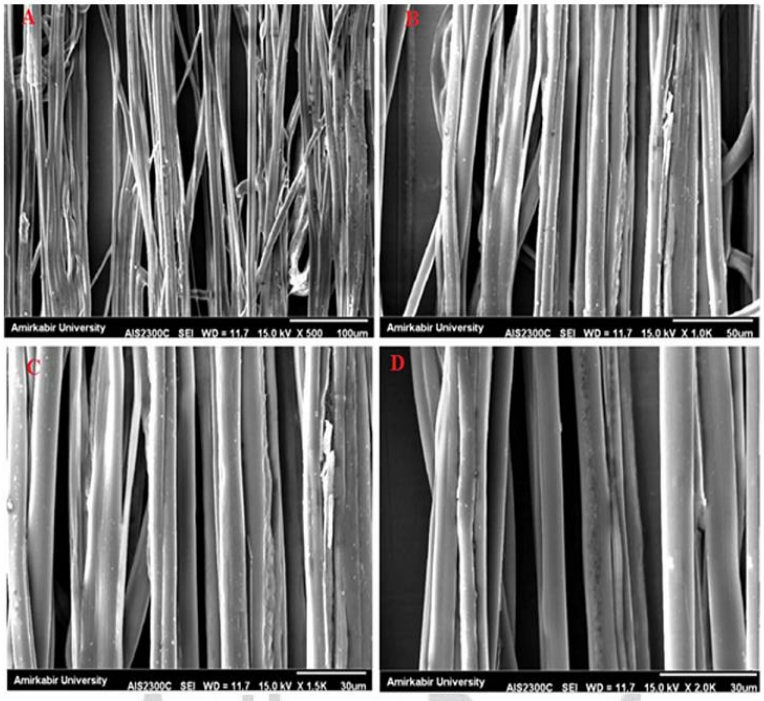
Nadri,S et al . J Biomed Mater Res Part A 2017:105A:189–197

Cell Viability and Control Release



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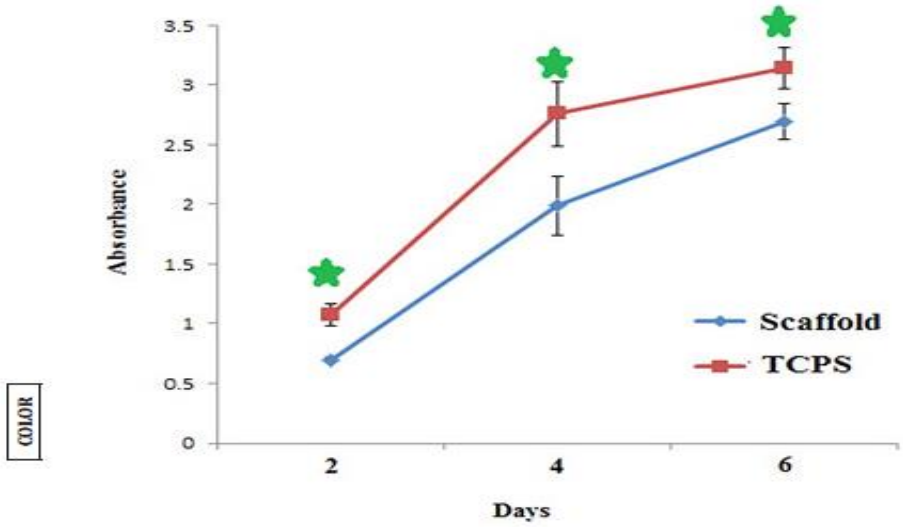

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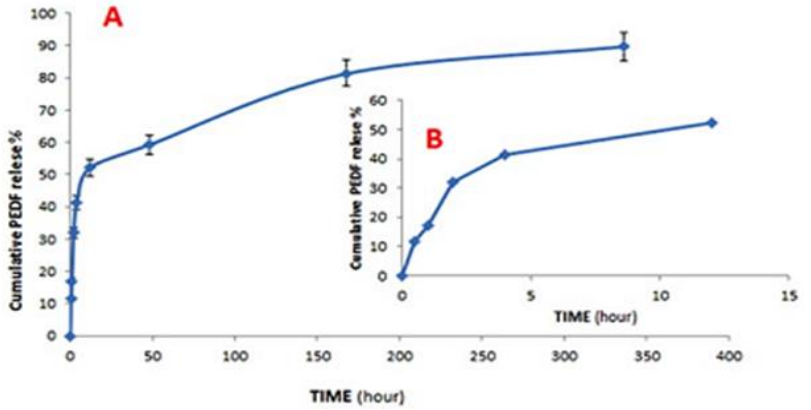

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FIGURE 4. Cumulative PEDF release profiles from the core-shell fibers in PBS (pH 7.4) PBS at 37°C during 14 days (A) and the first 12 h (B). The error bars represent the standard deviation values from the tests. $n = 3$, mean ± SD.

Nasehi, ……..Nadri, et al . J Biomed Mater Res Part A 2017:00A:000–000.

Change Morphology and Gene Expression

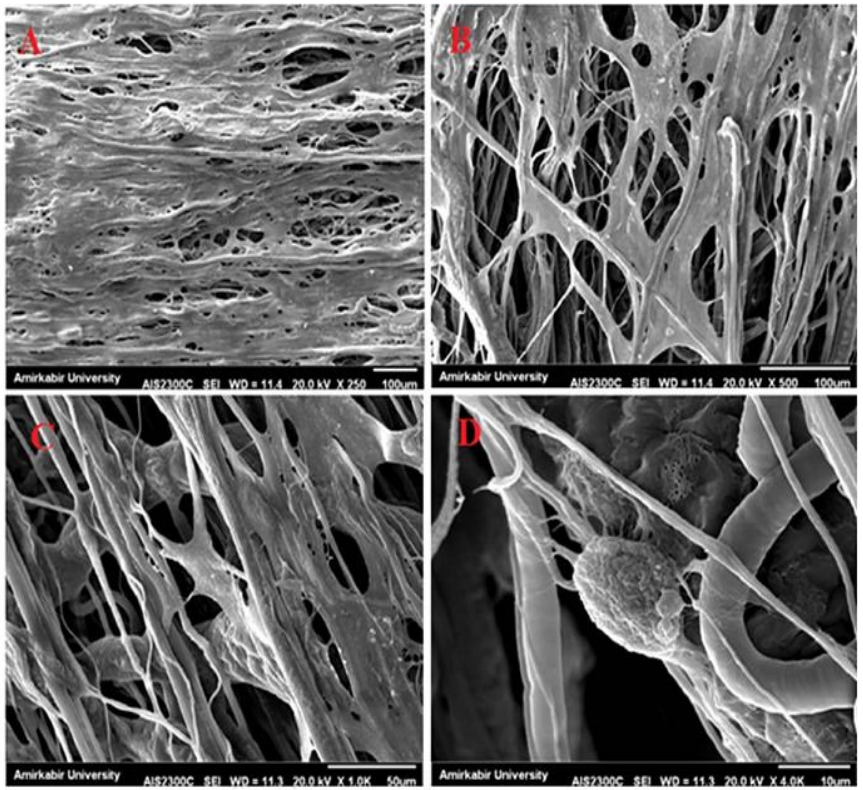

FIGURE 5. SEM micrographs of CJMSCs differentiated on PEG +PEDF/PCL scaffolds.

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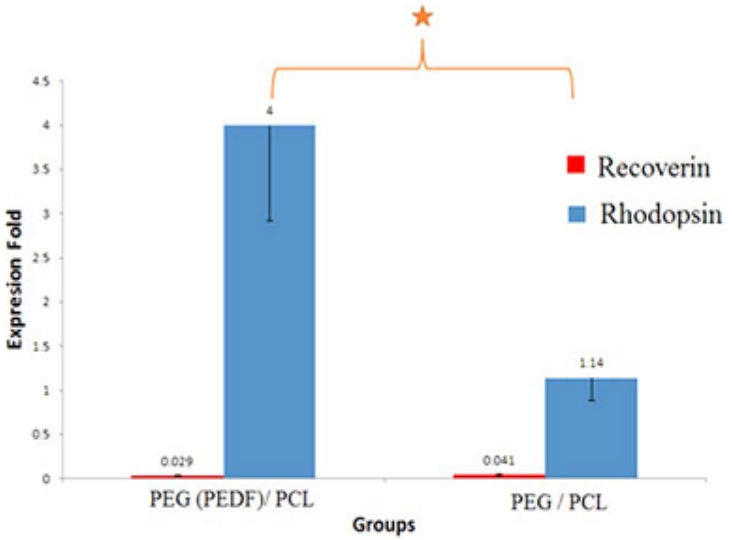

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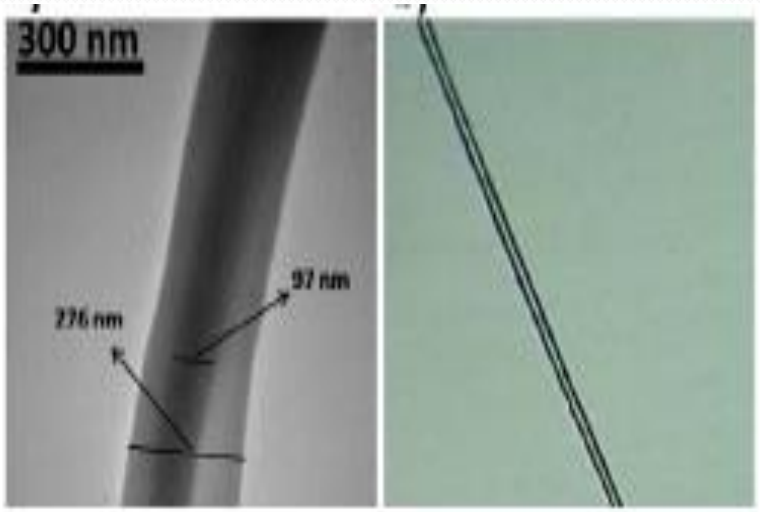
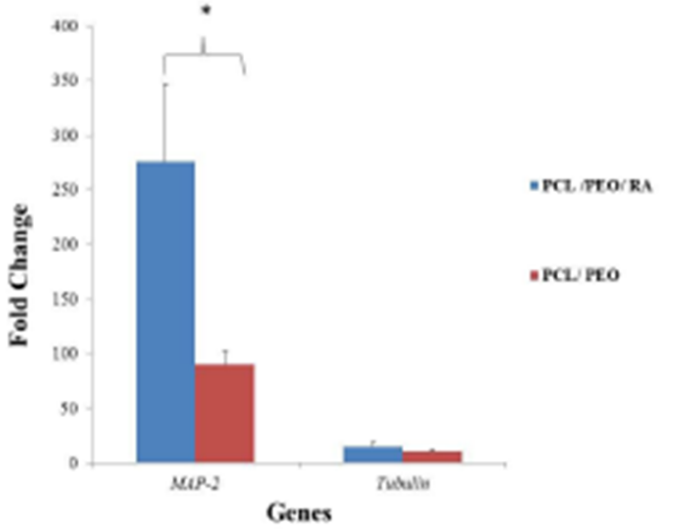
FIGURE 6. Gene expression profile of CJMSCs differentiated on core-shell scaffold included PEDF on day 14. The observed value of columns, compare the rhodopsin and recoverin gene expression in differentiated cells on the PEG + PEDF/PCL and PEG/PCL scaffolds. The column ratio of mRNA expression levels are the expression rate of genes compared with untreated cells on TCPS. TBP is shown as a control for RNA sample quality. Rest software was used for gene expression analysis using real-time PCR data. A statistically significant was indicated in an asterisk ($*p < 0.05$).

Nasehi,F ……..**Nadri,S** et al . J Biomed Mater Res Part A 2017:00A:000–000.

RA Delivery for Neural Differentiation





Asadi, Kh ….Nadri, S. Nanomed. J. 8(1): 73-79, Winter 2021

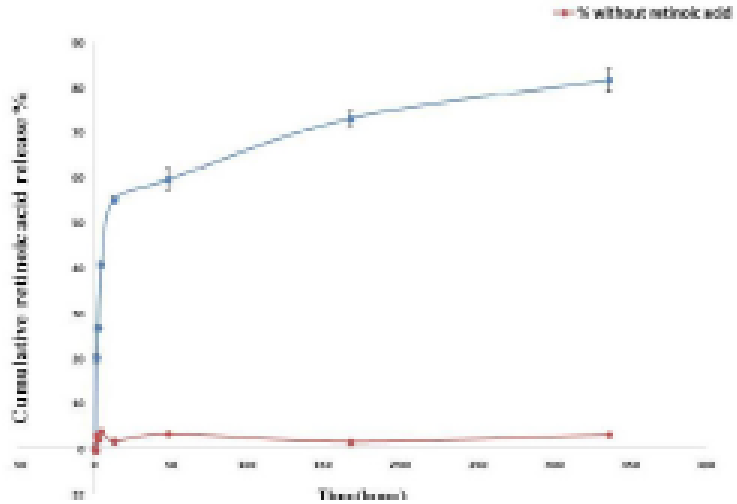


Fig 6. Cumulative retinoic acid release profiles from the core-shell fibers in PBS (pH 7.4, 37°C) during 14 days

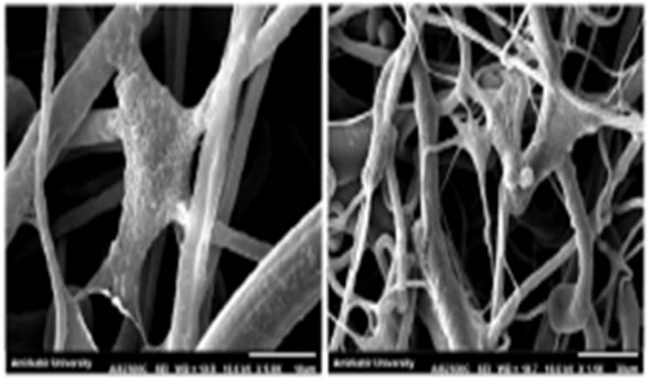


Fig 8. SEM micrographs of TM-MSCs differentiated on (A) PEO-PCL, (B) PEO- PCL +RA scaffolds


THANKS!