Biofabrication with functionalizable poly(amino acid) hydrogels towards development of bioengineered tissue constructs and biocompatible medical devices

Funding Agency	DST
Sanctioned Amount	Rs. 24.60 Lakhs
Project Duration	3 years
Project Status	Continuing sinceSeptember 2014

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Brief Description of the Project

Over the years, successes of tissue engineering are gradually percolating down to the society. A recent report indicated that several patients regained bowel function after received tissue engineered bladders, constructed from their own cells (autologous tissue engineering). However, it has also become obvious that traditional strategy of seeding cells onto scaffolds, which direct cell proliferation and differentiation into three-dimensional (3D) functioning tissues, have limitations to create the complexity of 3D organs. The requirement of manufacturing precise multi-cellular structures with vascular network integration is now well appreciated. Biofabrication aims to produce complex living and non-living systems to serve as biologic models, systems, devices and organ constructs by making use of live cells, molecules, extracellular matrix and biomaterials as the raw materials. Our project is aimed at developing suitable functional polymers which would be used for bio-fabrication using 3d printing and electro-spinning techniques preserving cell viability and functionality.

Keywords:Biofabrication, functional polymers, electrospun nanofibers, biocompatibility, medical devices, 3d printing, tissue engineering

Methodologies/Approaches Adopted

1. Synthesis and functionalization of polymers chitosan and polyglutamic. The synthesized polymer are characterized for their molecular weight, and spectroscopic signatures.
2. Electrospinning and 3d printing of the synthesized and modified polymers.
3. Culture of osteoblasts/fibroblasts cell lines.
4. Optimization of cell growth stage, cell density as well as material optimization w.r.t. viscosity of polymer solution.
5. Evaluation of cell viability, proliferation and differentiation by using MTT assays, live/dead cell staining and further characterization by osteoblast specific markers.

Project Highlights

e projects aims at developing suitable functional polymers (as bio-paper or bio-ink) for bio-fabrication applications. The unique approach lies in understanding the material properties of these polymers and how they affect cell behavior during fabrication. The project is aimed to target the tissue engineering and regenerative medicine clinical market sphere associated with tissue and organ loss due to surgery, trauma, accidents etc.

Project Achievements

1. It was possible to characterize the modified chitosan polymers, with improved bio-functionality.

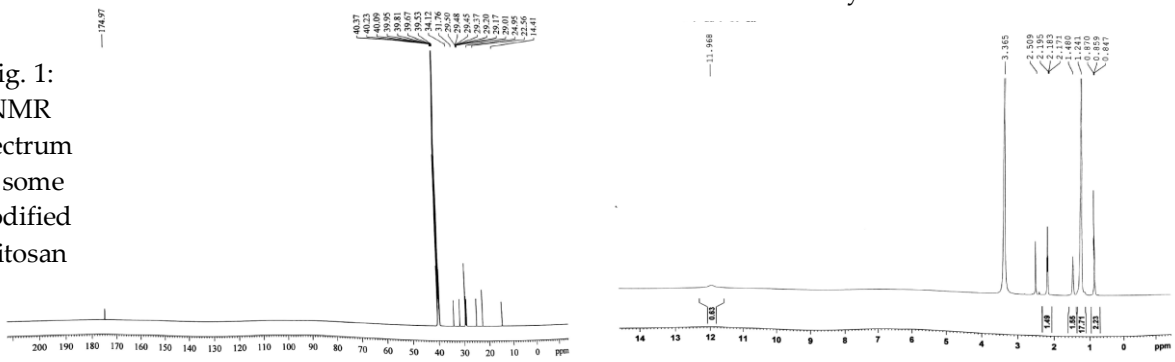

Fig. 1: NMR spectrum of some modified chitosan polymers.

2. Living tissue constructs could be made using the bio-fabrication approach.

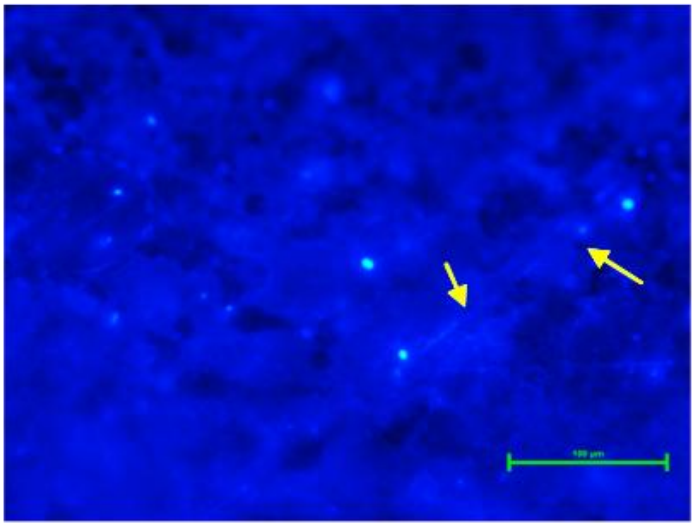

Fig. 2: Fluorescence microscopy images depicting DAPI stained cells. In this image very fine fibre in between two cells can still be visualized.

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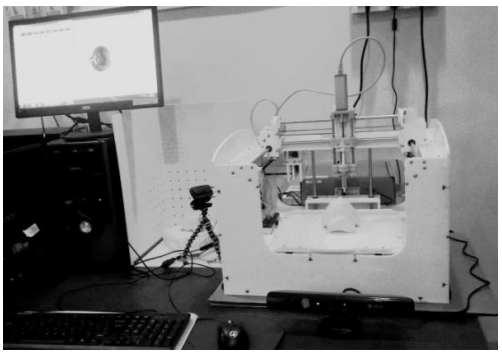
9. Jagadish.L.Italia, **Pallab Datta**, Dhawal D. Ankola, & M. N. V. Ravi Kumar. (2008). Nanoparticles enhance per oral bioavailability of poorly available molecules: Epigallocatechin gallate nanoparticles ameliorates cyclosporine induced nephrotoxicity in rats at three times lower dose than oral suspension. Journal of Biomedical Nanotechnology, 4, 304-3012; ISSN: 1550-7033.

Facilities Developed

1. 3D Printer Seraph Robotics, USA
2. Refrigerated Centrifuge, Hermle GmbH, Germany.
3. Refrigerated Water Bath, Lauda GmbH, Germany.
4. Vacuum Oven, Hahntech, South Korea



Biomaterials and fabrication laboratory at CHST showing electrospinning and 3d printing facilities.

Project Staff (Designation, number, name, qualification, leading to PhD, etc.)

1. Ms. Medha Majumdar (Junior Research Fellow, 9804192771, MSc.- Medical Biotechnology, School of Tropical Medicine, Kolkata)- Enrolled for PhD.

Plan of Future Project Proposal based on the Current Project

It is now under consideration to develop computational tissue engineering procedures based on the results of these project.