Dr. Falguni Pati

Assistant Professor (September, 2015 ~)
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Experience

- Post-Doc at Science for Life Laboratory, Division of Nanobiotechnology, KTH Royal Institute of Technology, Stockholm, Sweden from October, 2014 to August, 2015
- Post-Doc at Intelligent Manufacturing Systems Lab, Center for Rapid Prototyping based 3D tissue/Organ printing, Pohang University of Science and Technology (POSTECH), Pohang, South Korea from December, 2011 to October, 2014

Education

- PhD from Indian Institute of Technology, Kharagpur, India in September, 2011
- Master of Biomedical Engineering from Jadavpur University, Kolkata, India in 2007
- Bachelor of Pharmacy from Rajiv Gandhi University of Health Sciences, Karnataka, in 2004

Honours and Awards

- ✓ Awarded Brain Korea-21 (BK-21) fellowship for postdoctoral research work
- ✓ Awarded institute fellowship for PhD in IIT Kharagpur from 2007-11
- ✓ Qualified in Graduate Aptitude Test in Engineering (GATE) in 2005 with 95.04 percentile

Member of Organizations

- Life Member of Society for Polymer Science, India

Research Interest

My research interests include creating stem cell niche with decellularized extracellular matrix (dECM) for commitment of stem cells into tissue specific lineages and tissue printing with dECM bioink that is capable of providing an optimized microenvironment conducive to the growth of 3D structured tissue, where the intrinsic cellular morphologies and functions can be reconstituted. I also wish to understand differential cell-cell and cell-material interactions based on the structural and functional properties of the matrix.

I would like to develop in vitro tissue/organ models by 3D bioprinting technique that could provide an excellent alternative to current cell culture based or animal models for drug discovery and as in vitro disease/cancer models

Technology/product developed

- Developed and standardized decellularization protocol for processing of various tissue ECM for application in tissue engineering
- Developed 3D bioprinting methods including cells and biologicals using decellularized tissue matrix (dECM) for tissue engineering and regenerative medicine application
- Isolated collagen from novel sources with substantial potential to bring down the cost of this high-value product apart from generating economic value out of food processing waste products
- Designed and developed a laboratory scale wet spinning set up for rapid fabrication of biopolymer fibers for wound dressing and tissue engineering applications

List of Publications

Patent

- A process for the production of collagen and by-products from fresh water fish origin and application thereof (2011) Falguni Pati, Santanu Dhara and Basudam Adhikari (212/KOL/2011 dated 21st Feb 2011)

Book Chapters

1. Extrusion Bioprinting (2014), Falguni Pati, Jinah Jang, Jin Woo Lee, and Dong-Woo Cho (Invited Book Chapter), in Essentials of 3D Biofabrication and Translation, Anthony Atala and James J. Yoo (Editors), Elsevier, ISBN: 978-0128-010150
2. Biomimetic 3D Tissue Printing (2014), Falguni Pati, Joydip Kundu, Jin-Hyung Shim, and Dong Woo Cho (Invited Book Chapter), in Handbook of Biomimetics and Bioinspiration, Esmaiel Jabbari, Ali Khademhosseini, Deok-Ho Kim, and Amir Ghaemmaghami (Editors), World Scientific Publishing, ISBN: 978-981-4354-92-9.
3. Rapid Prototyping Technology for Bone Regeneration (2013), Joydip Kundu, Falguni Pati, Jin-Hyung Shim, and Dong Woo Cho (Invited Book Chapter) in Rapid prototyping of biomaterials: principles and applications, Roger Narayan (Editor), Woodhead Publishing Limited, ISBN-13: 978-0-85709-599-2.
4. Biomaterials for fabrication of 3D tissue scaffolds (2013), Joydip Kundu, Falguni Pati, Young Hun Jeong, and Dong Woo Cho (Invited Book Chapter) in Biofabrication, Grabor Forgacs and Wei Sun (Editors), Elsevier, ISBN: 978-1-4557-2852-7.

Peer Reviewed Articles in Journals

1. 3D bioprinting of tissue/organ models (2015), Falguni Pati, Jesper Gantelius, and Helene Andersson Svahn, **Angewandte Chemie International Edition**, *in press*
2. Biomimetic 3D tissue printing for soft tissue regeneration (2015), Falguni Pati, Dongheon Ha, Jinah Jang, Hyun Ho Han, Jong Won Rhie, and Dong Woo Cho, **Biomaterials**, *62*, 164–175
3. Ornamenting 3D printed scaffolds with cell-laid extracellular matrix for bone tissue regeneration (2015), Falguni Pati, Tae-Ha Song, Jinah Jang, Girdhari Rijal, Jong Won Rhie, and Dong Woo Cho, **Biomaterials**, *37*, 230-241
4. Bioprintable, cell-laden silk fibroin-gelatin hydrogel supporting multilineage differentiation of stem cells for fabrication of 3D tissue constructs (2015), Sanskrita Das,* Falguni Pati,* Yeong-Jin Choi,* Girdhari Rijal, Jin-Hyung Shim, Alok R. Ray, Dong-Woo Cho, and Sourabh Ghosh, **Acta Biomaterialia**, *11,* 233–246 (* equal contribution)
5. Printing three-dimensional tissue analogues with decellularized extracellular matrix bioink (2014), Falguni Pati, Jinah Jang, Dong-Heon Ha, Sung Won Kim, Jong-Won Rhie, Jin-Hyung Shim, Deok-Ho Kim, and Dong-Woo Cho, **Nature Communications**, *5,* 3935
6. 3D printing of cell-laden constructs for heterogeneous tissue regeneration (2013) Falguni Pati, Jin-Hyung Shim, Jung-Seob Lee, and Dong-Woo Cho, **Manufacturing Letters**, *1(1),* 49–53 (Invited article)
7. In vitro evaluation of osteoconductivity and cellular response of zirconia and alumina based ceramics (2013), Ajoy Kumar Pandey, Falguni Pati, Debika Mandal, Santanu Dhara, and Koushik Biswas, **Materials Science and Engineering: C**, *33 (7),* 3923-3930
8. Enhanced redifferentiation of chondrocytes on microperiodic silk/gelatin scaffolds: towards tailor-made tissue engineering (2013), Sanskrita Das, Falguni Pati, Shibu Chameettachal, Shikha Pahwa, Alok R. Ray, Santanu Dhara, and Sourabh Ghosh, **Biomacromolecules**, *14(2),* 311-21
9. Osteoblastic Cellular Responses on Ionically Cross-linked Chitosan- Tripolyphosphate Fibrous 3-D Mesh Scaffolds (2013), Falguni Pati, Hemjyoti Kalita, Basudam Adhikari, and Santanu Dhara, **Journal of Biomedical Materials research Part A**, *101 A (9),* 2526-2537
10. Development of Chitosan-Tripolyphosphate Non-woven Fibrous Scaffolds for Tissue Engineering Application (2012), Falguni Pati, Basudam Adhikari, and Santanu Dhara, **Journal of Materials Science: Materials in Medicine**, *23(4),* 1085-96
11. Collagen scaffolds derived from fresh water fish origin and their biocompatibility (2012), Falguni Pati, Pallab Datta, Basudam Adhikari, Santanu Dhara, Kuntal Ghosh and Pradeep Kumar Das Mohapatra, **Journal of Biomedical Materials research Part A**, *100A(4),* 1068–1079
12. Collagen intermingled chitosan-tripolyphosphate nano/micro fibrous scaffolds for tissue engineering application (2012), Falguni Pati, Basudam Adhikari and Santanu Dhara, **Journal of Biomaterials science, Polymer Edition**, *23 (15)* , 1923-1938

13. Development of chitosan-tripolyphosphate fibers through pH dependent ionotropic gelation (2011), Falguni Pati, Basudam Adhikari and Santanu Dhara, **Carbohydrate Research**, *346(16)*, 2582-2588
14. Development of ultrafine chitosan fibers through modified wetspinning technique (2011) Falguni Pati, Basudam Adhikari and Santanu Dhara, **Journal of Applied Polymer Science,** *121*, 1550–1557
15. Isolation and characterization of fish scale collagen of higher thermal stability (2010) Falguni Pati, Basudam Adhikari and Santanu Dhara, **Bioresource Technology** *101*, 3737-3742

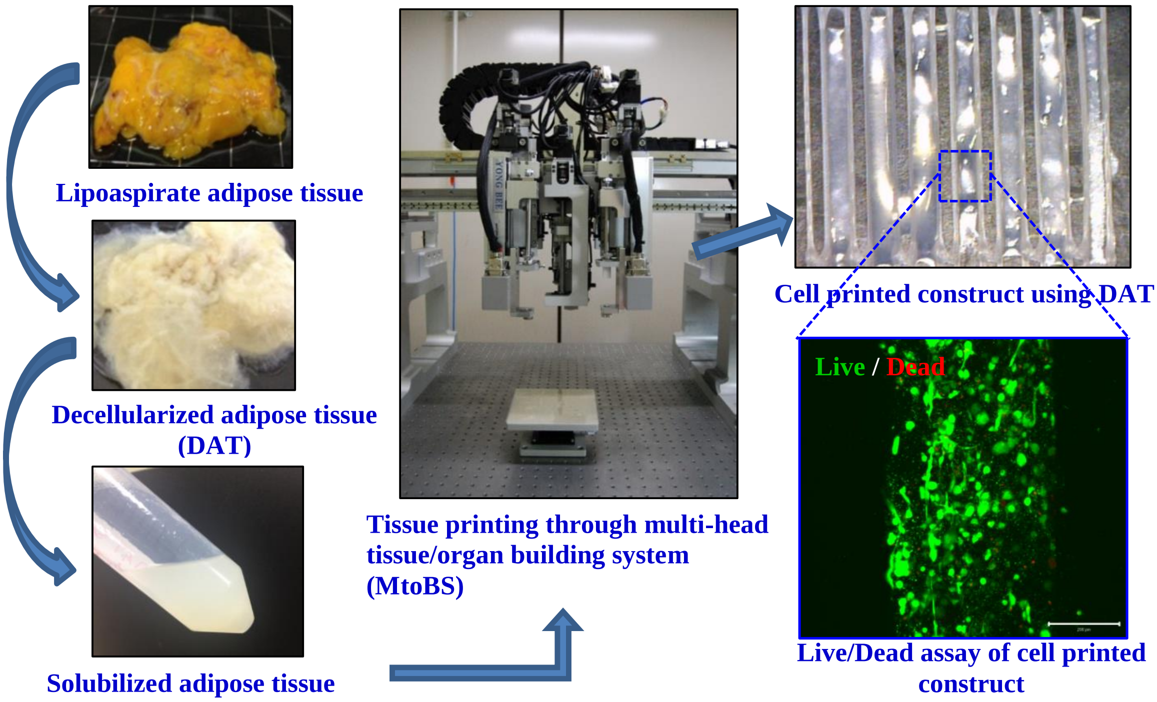
Abstracts in Conferences

1. Enhancing the biological performances of 3D printed scaffolds by ornamenting with cell-laid extracellular matrix: development of off-the-self bone graft substitute (2014), Falguni Pati, Tae-Ha Song, Girdhari Rijal, Jinah Jang, Sung Won Kim, and Dong-Woo Cho, International Conference on Biofabrication, Sep 30 2014, POSTECH, Pohang, South Korea.
2. Development of bio-ink and structure for breast tissue regeneration (2014), Falguni Pati, Dong-Heon Ha, Jinah Jang, and Dong-Woo Cho, Korean Society of Mechanical Engineers Annual Meeting, April 17-18, Gyengju, South Korea.
3. Bioprinting with decellularized extracellular matrix and its effectiveness for chondrogenic differentiation (2013), Jinah Jang, Falguni Pati, Tae-Ha Song, Sung Won Kim, Dong-Woo Cho, Biofabrication 2013, November 3-6, 2013, University of Texas at El Paso, El Paso, TX.
4. Cartilage tissue engineering using a hybrid of polymeric framework and cartilage-derived extracellular matrix with mesenchymal stromal cells from human inferior turbinate tissue (2012), Jinah Jang, Falguni Pati, Min Joo Kim, Sung-Won Kim, Dong-Woo Cho, 3rd TERMIS World Congress 2012, pp.373 , Vienna, Austria, September 5-8, 2012.
5. Freeze dried fish scale collagen: a potential matrix for tissue engineering and wound dressing (2010), Falguni Pati, Basudam Adhikari and Santanu Dhara, International Conference on Biotechnology and Food Science (ICBFS 2010), Bangalore on Feb. 9-10 (2010), published by World Academic Union (World Academic Press), UK. ISBN: 978-1-84626-036-0
6. Fish collagen: a potential material for biomedical application (2010), Falguni Pati, Basudam Adhikari and Santanu Dhara, IEEE TechSym 2010, 3-4 April, IIT Kharagpur.
7. Development of chitosan-tripolyphosphate fiber for biomedical application (2010), Falguni Pati, Pallab Datta, Jyotirmoy Chatterjee, Santanu Dhara and Basudam Adhikari, IEEE TechSym 2010, 3-4 April, IIT Kharagpur.
8. Effect of ionic and covalent crosslinking on physiochemical properties of chitosan fiber (2010), Paulomi Ghosh. Falguni Pati and Santanu Dhara, Macro 2010, 15-17 December, New delhi, India.
9. Electrospinning of collagen in aqueous system (2010), Pallab Datta, Falguni Pati, Soumi Dey Sarkar, Jyotirmoy Chatterjee, Santanu Dhara, ELECTROSPIN 2010, 26-29 January, Melbourne, Australia.

10. Chitosan-collagen composite scaffolds for tissue engineered skin (2010), Soumi Dey Sarkar, Brooke Farrugia, Tim Dargaville, Falguni Pati, Jyotirmoy Chatterjee and Santanu Dhara, TERMIS-AP 2010 Annual Conference, 15-17 September, Sydney, Australia.
11. Chitosan based membranes & scaffolds for orthopedic applications (2007), Sheba Rani N.D., Sugata Hazra, Falguni Pati and Subrata Pal, West Bengal Orthopaedic Association Conference, March, Kolkata, India.
12. Design and development of biomedical polymeric membranes & scaffolds from sea food industry waste (2007), Sheba Rani N.D., Sugata Hazra, Falguni Pati and Subrata Pal, 14th West Bengal State Science & Technology Congress, December, Kolkata, India.

Brief description about Research work

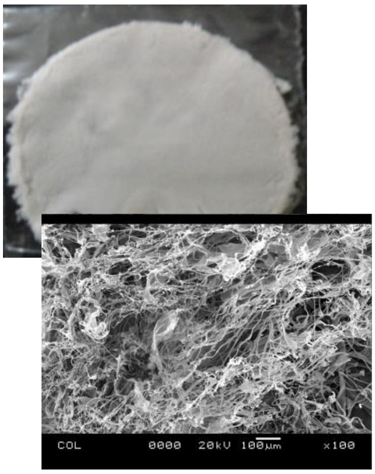
- Printing 3D tissues with decellularized extracellular matrix



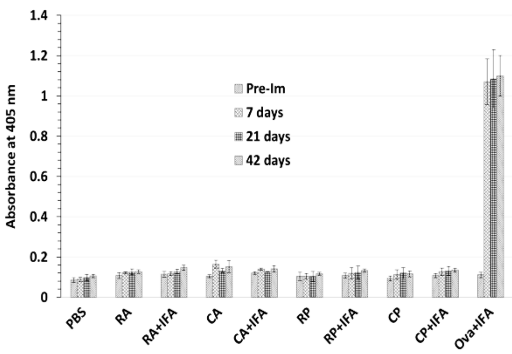
The ability to print tissue analog structure by delivering living cells with appropriate material in a defined and organized manner, at the right location, in sufficient numbers and within the right environment is critical for several emerging technologies, including tissue-engineering scaffolds, cell-based sensors, drug/toxicity screening, and tissue or tumor models. However, the majority of published work to date has used a very limited range of materials: sodium alginate, modified diblock copolymers, and photocured acrylates and these materials cannot offer the array of interactions that cells encounter in their native extracellular matrix (ECM). We developed a bioprinting method for printing of cell laden construct with tissue specific dECM, which provides an optimized microenvironment conducive to the growth of 3D structured tissue. A key advantage of this methodology is the preservation of tissue-specific ECM, providing crucial cues for cells engraftment, survival and long-term function.

- **Production of collagen from a novel source and their application in tissue engineering**

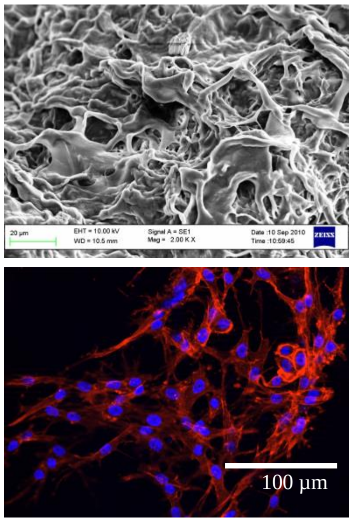
We have produced collagen from fresh water fish, which is a novel cost-effective source of this highly useful protein having numerous utility in different fields. It is first time that these species are used as sources of collagen. The isolated collagen was mainly type I. A major characteristic of obtained collagen was its denaturation temperature (T_d = 36.5 °C), which is promising as an advantage for biomedical application due to closeness in T_d to mammalian collagen. The isolated collagen did not show any immunogenic responses when injected to mice with incomplete Freund's adjuvant, without significant dilution of sera. Further, they encouraged enhanced cell attachment and proliferation.



Collagen sponge



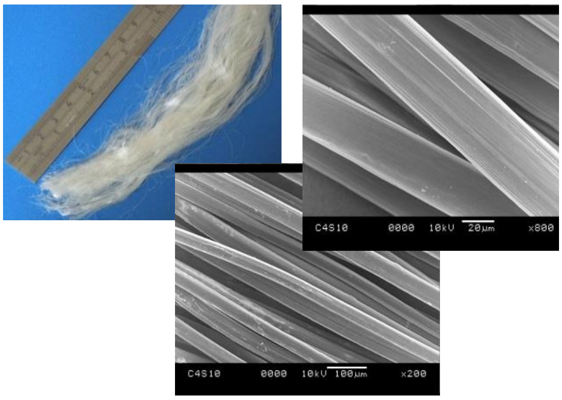
Immunogenic responses



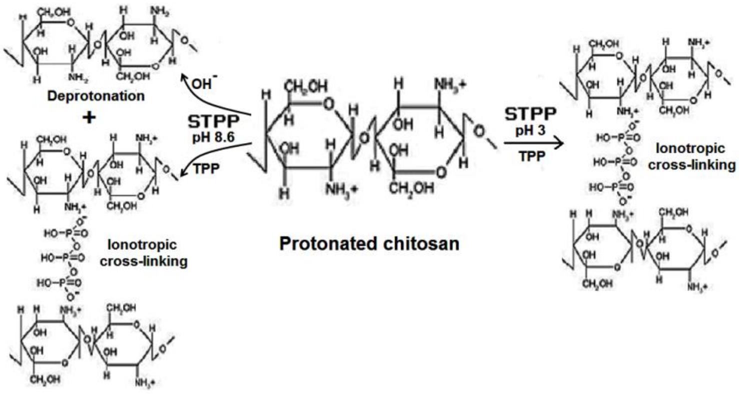
Cellular responses

- **Development Development of chitosan-tripolyphosphate fibers through pH-depended ionotropic cross-linking**

Chitosan can be cross-linked either by covalent or ionic bonding. Most of the covalent cross-linkers are toxic in nature and thus not suitable for biomedical uses. We have developed chitosan–tripolyphosphate fibers spun in sodium tripolyphosphate (STPP) bath, which capable of transforming polycationic acidic chitosan solution into gel instantaneously through ionic complexation with anionic tripolyphosphate (TPP). Further, chitosan fibers with varying phosphate contents were prepared by modulating coagulation bath pH and comparative analysis of mechanism of fiber formation was explained. Gelation kinetics and gel strength measurements of chitosan with STPP at different pH was carried out and found that STPP has pH dependent ionotropic cross-linking potential. Interestingly, ionotropic cross-linking causes reduction in crystallinity of chitosan-TPP fibers and enhanced their degradation rate. However, the increase in degradation rate of chitosan-TPP fibers without compromising their mechanical properties is advantageous for their use in tissue engineering.



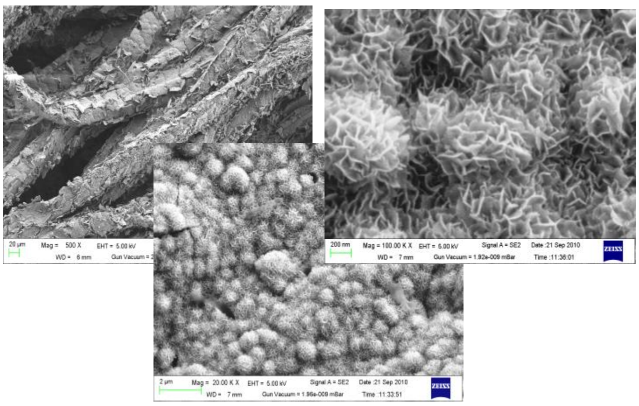
Chitosan microfibers



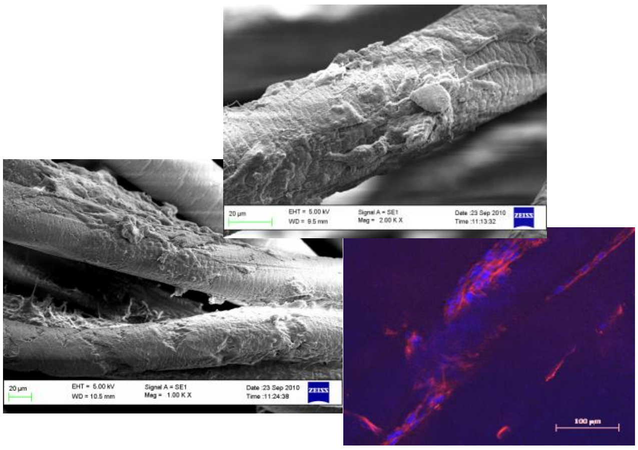
Gelation mechanism of chitosan in STPP solution at pH 3 and 8.6

- Osteoblastic cellular responses on chitosan-tripolyphosphate fibrous 3-d mesh scaffolds for bone tissue engineering

Although chitosan shows excellent biocompatibility, biodegradability and non-toxicity, unmodified chitosan membranes were reported to exhibit poor cell adhesion. Chitosan membrane modified by surface phosphorylation has been shown to promote the osteoblast cell viability, attachment and proliferation. I have developed phosphate incorporated chitosan-TPP fibers, which possess bioactivity, a prerequisite for bone tissue engineering application, when incubated in simulated body fluid. Further, a significant improvement in cell attachment, proliferation and differentiation was observed when osteoblast like cells were cultured on chitosan-TPP scaffolds than that of chitosan scaffolds without incorporated phosphate groups.



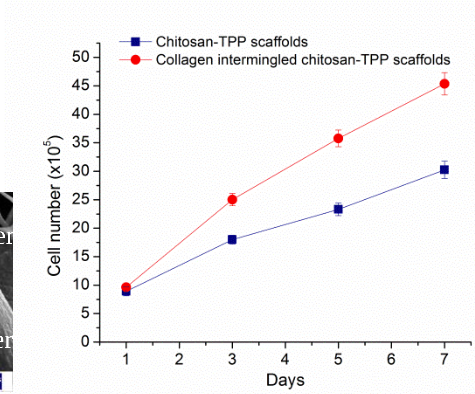
Biomineralized chitosan-TPP fibers



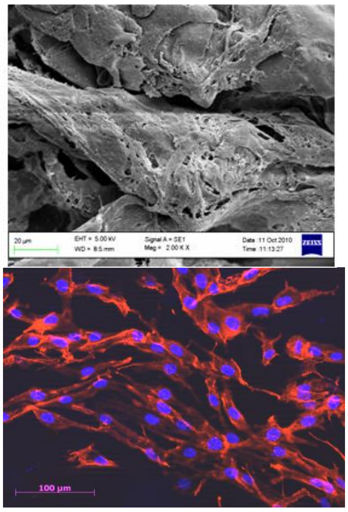
Attachment of MG63 cells on chitosan microfibers

- Collagen intermingled chitosan-tripolyphosphate nano/micro fibrous scaffolds for tissue-engineering application

Nano/Micro intermingled scaffold



Proliferation rate of MG63 cells on scaffolds

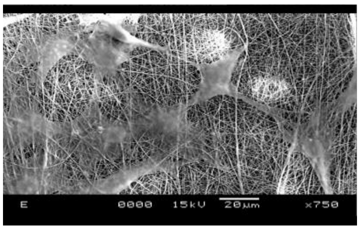


Attachment of MG63 cells on nano/micro fibrous scaffold

We have developed a novel structure which combines chitosan-TPP microfibers and collagen nanofibers in the same construct that is aimed to serve as a scaffold and mimic the physical structure of native extracellular matrix for tissue regeneration, where nanofibers provide a favorable surface morphology for cell attachment and growth and microfibers provide the structural environment. This nano/micro combined scaffold revealed remarkable cellular activity and cytocompatibility and supported improved attachment and proliferation of MG63 cells than that of bare chitosan-TPP scaffolds owing to presence of bioactive molecule, collagen, in the intermingled form with chitosan- TPP microfiber.

- Electrospinning of collagen from aqueous solution

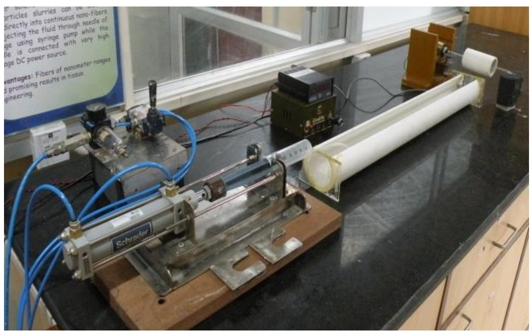
Collagen nanofibers were generally being elctrospun from organic solvents like HFP, which is toxic in nature. Thus, the developed nanofibrous scaffolds are not suitable for tissue engineering. We prepared collagen nanofibrous scaffolds from aqueous solution. The developed scaffolds supported excellent cell attachment and function.



Attachment of MG63 cells on nanofibrous elctrospun collagen scaffold

- Development of laboratory scale wet spinning setup

A laboratory scale wet spinning setup has been developed by us. This has got a separate attachment for holding the syringes and pressure application system. This spinning setup works on pneumatic pressure as opposed to the industrial use of pump for extrusion of polymers.



Laboratory scale wetspinning setup