National Institute of Technology Rourkela

Departmental Seminar

Seminar Title	: Evaluation of self-assembled nanofibrous aggregates (SNAs) for assessing osteogenic potential in the development of bioinks for bone tissue.
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Venue	: BM Department Seminar Room
Date and Time	: 24 Dec 2024 (11.30 AM)
Abstract	: Carbohydrates and proteins significantly influence stem cell fate and lineage determination through various mechanisms, including modulation of signaling pathways, altering metabolic programs, and providing structural components essential for cellular functions. Understanding the specific effects of carbohydrates and proteins on stem cell lineage determination opens new avenues for regenerative medicine. By understanding these factors, the efficiency of cell-based therapies for various diseases and injuries can be enhanced, potentially leading to improved clinical outcomes. This knowledge may also assist in designing improved scaffolds for tissue engineering that better support stem cell functionality. [1-2] Self-assembled nanofibrous aggregates (SNAs) based on polyelectrolyte complexes (carbohydrate–carbohydrate, and carbohydrate-protein) have garnered significant attention in the field of bone tissue engineering due to their unique properties, such as tunable mechanical strength, biocompatibility, and their ability to support cell proliferation and bone regeneration.[3] SNAs are formed by self-assembling oppositely charged polymers, resulting in diverse microstructures and tunable shear response. The intrinsic characteristics of these SNAs that determine stem cell differentiation without the need for growth factors remain to be fully explored. In this work, five combinations of 1:1 ratio (v/v) of SNAs were fabricated using chitosan, gelatin, casein, chondroitin sulphate and carrageenan. FESEM analysis, FTIR analysis, and zeta potential studies were performed to understand various aspects of these SNAs. Following this, these SNAs were incorporated in chitosan-based thermosensitive hydrogels (3% w/v), and their effects on physicochemical properties, printability, mechanical properties, and osteogenic potential using human bone marrow mesenchymal stem cells were assessed. The resulting SNAs-infused hydrogels exhibited distinct strengths across various properties. FESEM confirmed nanofibrous architecture across all SNAs. Furthermore, zeta potential showed chitosan – casein (Chi-Cas) and chitosan - gelatin (Chi-Gel) had positive charge of ~ 12 mV whereas Gel-Carr, chitosan – carrageenan (Chi-Carr), chitosan – chondroitin sulphate (Chi-CS) had negative charges of ~ -31 mV, -22 mV and -8 mV respectively. The water uptake potential of SNAs-incorporated hydrogels indicated that Gel-Carr hydrogel (H) had the highest value of ~ 16 % and Chi-Cas (H) had the lowest value of ~ 1.5 %. Similarly, Gel-Carr (H) had the slowest degradation over 30 days in the presence of 0.5 mg/ml lysozyme concentration. Cytotoxicity analysis indicated a cell viability of >90% in all the SNAs. Mechanical compression analysis of SNAs incorporated hydrogels showed Gel-Carr (H) had the lowest elastic modulus (~ 7 kPa), whereas Chi-Gel (H) had the highest (~ 11 kPa). Additionally, the gel fraction assay of all the hydrogels was above 50%. Considering the proliferation of encapsulated BM-MSCs within hydrogels over 14 days, Gel-Carr (H) had the highest cell concentration, confirmed by live-dead assay. Similarly, Gel-Carr had the highest ALP activity and collagen among all the SNAs of ~ 10 units/ml and ~ 0.5 OD550 nm, respectively, in osteogenic media. In conclusion, each SNA presents specific advantages and limitations, making them suitable for developing bioinks with tunable properties for bone tissue engineering. ALL ARE CORDIALLY INVITED