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Biomaterials in Tissue engineering

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A biomaterial is any matter, construct or surface which can be derived from natural or synthesized using metallic components, polymers, ceramics, or composite materials that interact with biological systems for a medical purpose. They restore function and facilitate healing for people after injury or disease. The biomaterial field combines the uses of biology, physics, chemistry, and medicine, and in a recent development, tissue engineering (TE) is the most influencing area. TE involves the repair, growth and improvement of damaged tissues to produce a fully functional organ for implantation back into the donor host. This repair and restoration process are mainly accomplished by engineered cells, engineered materials and methods. A variety of biomaterials including metal, plastics, ceramics, and even living cells and tissue can be used for creating a biomaterial. These engineered biomaterials are further re-engineered into coatings, films, fibres, foams, and fabrics that can be used in different biomedical products and devices. In current medical practices, biomaterials are being used in myriads of applications including medical implants (dental implants, stents and grafts, artificial ligaments, heart valves, etc.), healing kits (sutures, clips, dissolvable dressings), regenerated human tissues, molecular probes for imaging and treatment, and drug delivery systems.

Scaffolds play an integrated role in TE by providing a platform for the adhesion, and proliferation of cells and tissue and also serve as a vehicle for delivering drug molecules to the target site. Biodegradability, pore size, mechanical stability, piezoelectric property, wettability, and biocompatibility are the prerequisite properties of scaffolds. Polymers are versatile biomaterials which exhibit ultimate biological attributes for cell regeneration as they offer excellent cell viability and biocompatibility similar to that observed in the biological system. The polymeric biomaterials can also be incorporated with natural materials and inorganic nanoparticles to accomplish novel, exclusive, and synergistic products for better performance. The interaction between cells and material is very crucial for the application of biomaterials in the clinical field. There are major aspects like topology, surface chemistry, and mechanical indications that influence cell responses like cell adhesion, proliferation, migration, and differentiation which can be modulated by biomaterial modifications. Self-assembled block copolymers into micelles and vesicles can be used as a vehicle for carrying drugs to desired targets. In recent years, a cationic polymer such as polyethyleneimine-based non-viral vectors has been used to deliver local or systemic target gene delivery to tumour tissue.

Polymer-based scaffolds with pre-customized size and shape on microscale or nanoscale have been used for the fabrication of bone, cartilages, skin, cardiovascular, nerve and other applications of TE. Polymeric biomaterials, mostly biodegradable polymers such as the family of poly(α-hydroxy esters) including poly(glycolic acid), and poly(lactic acid), and their copolymers poly(lactic-co-glycolic acid) have been used extensively in medical and surgical applications as approved by US Food and Drug Administration. In the recent past, naturally, biodegradable polyhydroxyalkanoate (PHA) and its copolymers have been of interest primarily because of better physicochemical, mechanical and thermal properties and these properties can be elevated to produce well-defined highly porous scaffolds which can further meet the practical demand of tissue engineering application. Poly (3-hydroxyvalerate), as one member of PHA copolymer, has now been permitted for wound dressing. After significant modifications, polyester biomaterials are widely being utilized for scaffolds, tissue engineering, drug and antigen delivery, and as antimicrobials. In the future, more advancement is required to get different types of biomaterials such as immunomodulating biomaterials, injectable biomaterials and supramolecular biomaterials which can modulate the immune response, target delivery of therapeutic agents and mimic natural biological signals respectively.

Biography

Ruma Rani is a SERB-National Postdoctoral Fellow in the Parasitology Lab at ICAR-National Research Centre on Equines, India, where she is working on the development of an antibody-based diagnosis of Trypanosoma evansi infection. Her area of interest is nanomedicine and drug delivery system, in vitro and in-vivo pharmacological evaluations, molecular diagnosis; biomaterial and their applications. Dr Ruma did her PhD in 2018 in the field of nanoparticulate drug delivery systems from Guru Jambheshwar University of Science and Technology, India. She has been awarded by the prestigious fellowship ‘INSPIRE’ by the Department of Science and Technology, Ministry of Science and Technology, Govt of India, for full-time PhD study. She has also been awarded by CSIR-Research Associateship (2019-2022) and completed her project. She has presented her research work at many national and international conferences. She has published more than 20 papers in reputed journals.