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Emerging Regenerative Niches

Kanchana Amaranth*

Associate Professor, Sathyabama Dental College and Hospitals, Chennai-600119, Tamil Nadu, India

Introduction

It is both a pleasure and an honor to take over as an Editor of this special issue of **"Emerging and smart devise strategies in biomaterials and scaffolds for tissue engineering"**. This journal stands in a distinctive position in our profession, having a great potential to influence the direction in which our research goes. Consequently, "central purpose of this special issue is to convey the richness, breadth and unity of the field by presenting the latest advancements in biomaterial science combined with basic scientific technology and potential impact on the development of new molecules with novel clinical approaches for the repair of tissues, organs, gene therapy and stem cells therapeutics accessible to the wide community of multi-disciplinary researchers".

Tissue Engineering (TE) is a technology with profound benefits and enormous potential that offers future promise in the treatment of tissue or organ dysfunction as well as for genetic disorders. Over the last quarter of a century there has been an emergence of a tissue engineering research where the major medical challenges that has likely to be evolved into the broader area of regenerative medicine. One of the main motivations for TE research is the chronic shortage of organ donors and other limitations related to organ and tissue transplantation. Regeneration of tissues and organs remains one of the vast challenges of experimental medicine, and physicians are frequently in quest of better methods for tissue repair and replacement. TE and regenerative medicine have been explored for almost every organ system in the human body, and development is made possible from several interrelated, well-established disciplines, including cell biology, stem cell research, biochemistry and molecular biology, that independently and jointly feed the understanding of complex living systems. Therefore, there is a great interest in the possibility of repairing the organ system by transplanting cells that can replace the lost cell populations as grafts for the treatment of traumas/diseases of the musculoskeletal system, and or 3D model systems to investigate fundamental aspects of cell proliferation, differentiation and consequent tissue regeneration under controlled and defined conditions.

Over the past two decades there has been a tremendous interest in the application of TE protocols and stem cells (particularly Mesenchymal Stem Cells) for the forefront of a new wave of possible therapeutic strategies. Earlier 21st century saw the materialization of cell-based clinical rehabilitation using MSCs at different approaches which involves, seeding of MSCs into 3D scaffolds to produce functional tissues for replacement of defective ones; MSC transplantation to replace defective host cells and exploiting the properties of MSCs to act as growth factor producer to encourage repair or inhibit degenerative processes. The advancement of TE and stem cell strategies is strongly dependent on the development of biomaterials, scaffolds and nanotechnology concepts that meet the meticulous design criteria of regenerative medicine. Scaffolding, is a multifaceted subject and a vibrant support for tissue engineering, which involves the interaction of various areas of knowledge, such that new scaffolds are frequently being developed, fabricated, improved, transformed and evaluated. Apparently, scaffolds seems to be the central components of various tissue engineering strategies, because they provide an architectural context in which extracellular matrix, cell-cell and growth factor interactions combine to generate regenerative niche.

A major problem with some TE scaffolds is that, once the cells begin to get too deep into the pores, they don't receive enough nutrients or oxygen, because the top layers of cells would be blocked for their movement into the lower layers. A promising innovation in 2011, called a solid freeform scaffold, gets around this problem, as it was designed with artificial blood vessels that carried these nutrients and remove waste products. Further, the advances in nanotechnology can bring additional functionality to vascular TE, optimize internal vascular graft surface, help to direct the differentiation of stem cells into the vascular cell phenotype, and, most importantly, also provide a biomaterials-based cellularization process.

Despite the advancements in the field of TE and scaffolds for tissue engineering, there are few challenges, which need to be undertaken. The type of challenge varies with the choice of emerging biomaterials used for scaffolding for the development of tissues. Over the past two decades, a lot of research work has been done to design, develop and experimentally demonstrate the increasing advantages of polymeric matrices to provide structural foundation to support tissues undergoing constant remodeling, integration and restructuring.

Many attempts have been made emphasized to produce various smart systems using various natural polymers (Collagen or fibrin, polysaccharides, like chitosan, alginate and hyaluronic acid) and synthetic (as Poly Lactic Acid (PLA), Poly Glycolic Acid (PGA), Poly(ε-Caprolactone) (PCL), and polycarbonates like Poly Trimethylene Carbonate (PTMC), as well as their copolymers) polymers that could be used in tissue engineering applications, including fabrication of scaffolds that can deliver appropriate drug molecules like antibiotics, proteins, growth factors etc. Although, biodegradable polymers present some limitations such as difficulties in controlling the variability from batch to batch and mechanical properties, their degradability, biocompatibility, low cost and availability, similarity with ECM and intrinsic cellular interactions makes them attractive candidates for various biomedical applications, in particular as drug delivery systems for TE applications. Indeed, yet another category of biomaterials involves the so called biomimetic materials, the typical third generation bio-interactive biomaterials, where biological principles have been incorporated in biomaterials design. However, a long standing problem in the use of these conventional scaffolds lies in the impossibility of re-loading

***Corresponding author:** Dr. Kanchana Amaranth, Associate Professor, Sathyabama Dental College and Hospitals, Chennai-600119, Tamil Nadu, India, E-mail: kanchana.amarnath@gmail.com

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the scaffold with the bio-agents after implantation. The researchers, succeeded in developing a simple and inexpensive technique able to transform standard commercial scaffolds made of hydroxyapatite and collagen in magnetic scaffolds to take up *in vivo* growth factors, stem cells or other bio-agents bound to magnetic particles.

Thus in the near term, a central challenge by integrating engineering and experimental medicine, this journal identifies research priorities to understand novel biomaterials that are emerging to bring successful therapies thereby forming a bridge between laboratory and clinic. We anticipate for the original contributions promoting synergies through influence and interaction of multiple disciplines like, designing of 3D biomaterials and scaffolds as tissue substitutes; innovative *in vitro* and *in vivo* approaches for tissue regeneration and a potential strategy to construct a carrier system for controlled/sustained release.

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