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Editorial

Tissue science and stem cell research

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There are many different ways in which stem cell research and tissue engineering can advance of regenerative medicine therapies. Combining stem cells with novel scaffolds provides a promising strategy for engineering tissues. The structure, dynamics, and the corresponding biological properties of scaffolds cannot be fully understood and optimized without taking into account solvent hydration and the effect of the ionic atmosphere. Biomaterials operate at cellular and subcellular levels. Consequently, physical properties like osmotic and mechanical properties, charge density, etc., must be known on distance scales below 1000 Å. Ions are implicated in a wide-range of physiological processes.

Tissue engineering is an emerging field that combines the technologies of molecular and cell biology with those of advanced materials science and engineering. It is a relatively new approach for the treatment of disease and injury. In this method, an artificial extracellular matrix or scaffold, either from natural or synthetic origin is used to mimic natural physiological conditions, accommodate mammalian cells and guide their growth. The first commercial application of engineered tissue was an artificial skin product developed for burn treatment in the 1990s. More recent applications include cartilage, bone, heart, etc.

The stem cell field is advancing rapidly, opening new avenues for cellular therapy and tissue engineering. The use of adult stem cells for tissue engineering applications is promising. However, existing scaffolds for tissue engineering are found to be less than ideal for many applications. An important shortcoming is that scaffolds lack sufficient mechanical strength. They also lack of appropriate structural and biochemical integrity with the host tissue, which is an essential requirement for cell growth and tissue regeneration.

Tissue engineering scaffolds are used to promote the viability and differentiation of stem cells based on the intrinsic properties of the biomaterial. Although much has been understood during the last decade about the assembly of biomaterials into 3D objects, relatively little is known how their hierarchical organization affects the physical properties, such as mechanical and osmotic properties. However, this knowledge has direct relevance to understanding the design principles of scaffolds for tissue engineering applications. The key to understanding the behavior of such complex systems requires a multi-scale integrative approach exploring the governing mechanisms across a wide span of length and time scales.

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