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Understanding the extracellular matrix

Tissue engineering deals with the growth and regeneration techniques of connective tissues or organs from a combination of cells and a scaffold to produce a functional organ. The engineering techniques therefore begin with an implantation of artificial materials, providing a proper environment for cells or tissues to be grown and functionalized. The scaffolds are often formulated with biodegradable polymer, extracellular matrix, and growth factors, serving as a skeleton to be filled up with cells, and eventually grow into three-dimensional tissues. With the importance of the intercellular connection in the field of tissue engineering, considerable efforts have been made to design an artificial extracellular matrix *in vitro*: to achieve a three-dimensional network in its architecture and effective ingredients for its chemical composition.

Another important aspect, however, that I would like to emphasize, is understanding how sophisticated the interaction is between the extracellular matrix network and cytoskeletal networks in cells. The cytoskeletal network in most eukaryotic cells is a combination of polymeric networks made of actin filaments, microtubules, and intermediate filaments. These networks play an essential role in determining not only the shape and mechanics of a cell, but more importantly, cell motility. In particular, an orchestrated movement of cells in particular directions to specific locations is essentially required during any tissue development in nature. These cellular migrations are often explained by a cytoskeletal model; the spontaneous cycling of polymerization and depolymerization of cytoskeletal filaments leads the cellular motility at the cell's front, where a tight interface with the extracellular network occurs.

The concept of symmetry breaking is helpful for understanding the cytoskeletal mech-

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anisms of a cell; for example, individual actin filaments and microtubules are structurally and kinetically polarized to generate pushing forces and pulling forces, which are indicative of the asymmetric nature of the filament organization in cytoskeletal networks. The mechanical properties of the external network are known to influence the polarized organization of cytoskeletal fibers in the target cells. Therefore, if an optimized extracellular matrix-based scaffold, from a simple supporting scaffold to a more complex dynamic bioactive environment, is to be provided, then one has to understand that the internal cytoskeletal fibers may respond differently to the given extracellular matrices, not only biologically but also physically. Hence, the effectiveness of both the cellular growth (chemical response) and cellular migration (physical response) should be reassessed, and scrutinized.

Just the fact that researchers have been able to understand tissue growth and regeneration at this level of detail is itself impressive. What is more remarkable is that scientists are now developing technology to shape and even replicate these processes through the design of artificial extracellular matrices and the associated techniques and materials to implement their use. As these technologies move from the laboratory to clinical practice, they are bound to shape the field of periodontal and implant science in the future and have a positive impact on the quality of life of our patients. We should welcome these developments and encourage the ongoing growth of cell and tissue engineering.

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