Conference on Orthodontic Advances in Science and Technology (COAST) "Craniofacial Skeletal Bioengineering" held at Asilomar Conference Center, Pacific Grove, CA, USA, August 27–30, 2004

The main focus of this second biennial conference was current concepts in tissue engineering, potential successes and limitations and specific issues related to clinical applications (especially in the craniofacial complex). The three major components used in tissue engineering are scaffolds, cells and stimulants. Papers on these topics have been included in this issue of Orthodontics and Craniofacial Research. Currently, tissue engineering is transitioning from developing homogenous single tissues such as bone and cartilage to either heterogeneous tissues or complex organs such as joints, teeth and periodontium. These and their applications to craniofacial healthcare will be the focus of a second issue that will appear in November 2005.

There is a revolution in the medical implant industry driven by advances in molecular and cell biology combined with engineering. A new branch of healthcare, known as regenerative medicine, has emerged focusing on the replacement, repair and regeneration of tissues and organs using biological approaches. This specialty will be served by an industry that must address issues related to product availability, sources of cells, development of scaffolds, creation of specific bioreactor technology to scale up tissues and organs, and conditioning them for optimal functioning after implantation. Success will be contingent on understanding the biology of the various systems and applying this knowledge to engineering.

A key component for successfully engineering desired tissues is the use of appropriate scaffolds and the availability or release of relevant stimuli at optimal time-points during the development of the cell and the formation of the tissue. This group of papers addresses some of the scaffolds in common use today together with their advantages and limitations for use in engineering specific tissues. These papers highlight modifications that may further enhance the utility and versatility of various scaffold materials to overcome their biologic or mechanical limitations. The mechanical limitations of a number of scaffolds include the difficulty of controlling final shape, size or mechanical properties of the product. The lack of adequate mechanical properties of bioengineered skeletal tissues remains a significant shortcoming, and ideas for making further advances in this area were also presented.

A greater understanding of how differentiated or stem cells respond to different scaffolds will enhance our ability to select appropriate materials or modify them as necessary to produce the desired results during tissue engineering. This topic as well as recent findings discussing the mechanisms of cell interactions with specific scaffolds and some of the biologic challenges, including transfer of nutrients, vascularization, attachment and migration of cells also are presented. Both differentiated cells as well as adult and embryonic stem cells are currently used for tissue engineering. While the potential for differentiated cells in tissue regeneration continues to be explored, the use of stem cells, including adult stem cells, is preferred for tissue engineering because of their plasticity, multipotency and potential greater availability with lower morbidity.

Growth factors direct the phenotype of both differentiated and stem cells. Methods used to deliver these molecules include delivery of the protein itself, genes encoding the factor, or cells secreting the factor were presented. New developments in scaffolds provide the added ability for them to serve as reservoirs for release of drugs and genes both as a therapeutic approach and for tissue engineering.

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