

Tissue Engineering : An Exciting Development with Great Challenges

The newly emerging field of tissue engineering is defined as "an interdisciplinary field that applies the principles of engineering and life science towards the development of biological substitutes that restore, maintain and improve the function of damaged tissues and organs" (Skalak and Fax 1988, Langer and Vacanti, 1993; Nerem; 1991) Developments that led to formation of the concept of tissue engineering, using cells and biodegradable polymer scaffolds, arose from the shortage of organ available for transplantation. Organ Transplantation is limited by the lack of organ donors, possible rejection of the transplanted tissue and other complications.

The use of living cells and extracellular matrix components to build biological substitutes as supplements or alternatives to whole organ or tissue transplantation is an attractive approach to the problem. The advantage of this approach over whole organ transplantation is that only the cells of interest are implanted, and they can potentially be multiplied in vitro. Thus a small piece of excised tissue can be grown into a large tissue mass which is then available for transplantation to a number of recipient. This should reduce the cost of therapy. The use of immune suppression may also be avoided by using the patient's own cells.

Three basic strategies are utilized in tissue engineering which include:-1) cell sources ; which may be stem cells or any differentiated cells 2) a matrix system ; using biodegradable polymers and 3) an appropriate environment ; growth factors etc.

Progression from concept to experiment has moved quickly. Many models have been developed in the laboratory for liver, heart valves, cartilage, tendon, urothelial tissue, intestine etc.

The source of cells to produce these tissue is a major challenge. The challenge is to understand the principles of stem cell biology and then apply it to tissue engineering. The use of embryonic stem cells faces ethical questions. Umbilical cord blood stem cells from the new born infant and adult stem cells derived from bone marrow may be better alternatives. Other stem cell reservoirs for mesenchymal tissue such as muscle, bone, and cartilage, or endodermally derived tissue such as intestine and liver, or ectodermally derived tissues such as nerve and skin are under investigation.

The biomaterials used to combine with living cells to produce the engineered "organ" or tissue can be permanent or biodegradable. They can be naturally occurring materials, synthetic materials, or hybrid materials. They need to be developed to be compatible with living cells in vitro and in vivo. A clear understanding of the interface of these materials with the living cells and the implant site is necessary. The design characteristics of these materials are one of the major challenges in the field of tissue engineering.

Although these models remain at an early stage of development, tissue engineering holds the potential to make a tremendous impact in medicine and reconstructive surgery.

Chongdee Aojanepong

*Division of Plastic Surgery,
Department of Surgery, Faculty of Medicine
Siriraj Hospital, Mahidol University,
Bangkok 10700, Thailand.*

REFERENCES

1. Vacanti JP, Vacanti CA. The challenge of tissue engineering. In : Lanza RP, ed. Principles of Tissue Engineering. R.G. Landes Company, Austin, Texas, 1997.
2. Chaignaud BE, Langer RS, Vacanti JP. The history of tissue engineering using biodegradable synthetic polymer scaffolds and cells. In : Atala A, Mooney DJ, eds. Synthetic Biodegradable Polymer Scaffolds. Birkhauser, Boston, 1997.