9th Yazd International Congress and Student Award on Reproductive Medicine with 4th Congress of Reproductive Genetics

Key Lectures

K-62
An introduction to tissue engineering: How to select the best cells

Zandieh Doulabi B.
Department of Oral Cell Biology, Academic Centre for Dentistry Amsterdam (ACTA), University of Amsterdam and VU University Amsterdam, Amsterdam, Netherland.
Email: bzandiehdoulabi@acta.nl

Stem cells are special cells that are able to develop into many different cell types and or tissues, ranging from bone cells to brain cells. Stem cells are divided into embryonic stem cells and adult stem cells Subtypes. Embryonic stem cells (ESC's) and induced pluripotent stem cells (iPSC's) can turn into more than one type of cell from different origins. Adult stem cells can differentiate toward one tissue (such as the liver) or to multiple tissues (such as the bone, brain, and cartilage) from the same origin in the case of mesenchymal stem cells. Given their unique regenerative abilities, stem cells offer new potentials to repair or treat diseases such as bone and cartilage defects, diabetes, and heart disease.

The general principles of tissue-engineering involve combining stem cells, a natural/synthetic scaffold, and required chemical/mechanical factors to build a functionally, structurally and mechanically compatible living tissue.

An ideal tissue engineered construct needs an excellent microenvironment with the optimal cell adhesion, growth, and differentiation capacity in controlled pH, temperature, oxygen tension and be properly adapted to the mechanical force of the microenvironment. Therefore, besides the choice of stem cells, the development of such a construct requires a careful selection of three key components: 1) scaffold, 2) growth factors, 3) extracellular matrix.

For the permanent repair of damaged tissues, the following criteria are essential to consider:

- An adequate number of cells and their ability to differentiate into desired phenotypes,
- Cells must be able to adapt to the three-dimensional structure and produce their own extracellular matrix
- Tissue-engineered cells also must be structurally and mechanically compliant with the native cells and be able to integrate with native cells without the risk of immunological rejection and pose no biological risks.

The source of cells utilized in tissue engineering can be autologous (from the patient), allogenic (from a human donor but not immunologically identical), or xenogeneic (from a different species donor). Each stem cells source has its (dis) advantages in usage. For example, the autologous cells represent an excellent source for use in tissue engineering because of the low association with immune complications but their use is in general not cost-effective for batch controlled clinical use. In contrast, allogenic cells and xenogeneic stem cells offer advantages over autologous cells in terms of uniformity, standardization of procedure, quality control, and cost-effectiveness. Their disadvantage may lie in immunogenic related adverse effects.

In conclusion, the use of an appropriate multipotent or pluripotent stem cell in tissue engineering is an emerging concept. Many technical questions need to be answered and require close collaborations between scientists, clinicians, engineers, and legal and ethical regulating bodies (for example when embryonic stem cells or genome-edited iPSC's are used) to obtain the goal of functional tissue restoration.