Tissue engineering principle

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Tissue engineering priciples

The goal of tissue engineering is to replace or even improve biological tissues and their functions by the use of engineering methods and life sciences. There are a lot of different tissues to be artificially formed, as bone, vessels, bladder, muscle etc. Tissue engineering is closely related to regenerative medicine.

Tissue engineering consists of 4 main factors:

1) Scaffold (artificial structure which is capable of supporting tissue formation in 3 dimensional space)

2) Living cells/tissue

3) Control over growth factors

4) Culturing (includes maintenance of oxygen, pH, humidity, temperature, nutrients and osmotic pressure)

Now there are 5 main steps in growing new tissue by applying these factors:

1) Isolation of cells during biopsy (Usually done by centrifugation or apheresis. First the cells have to be in a free floating state; to achieve this the tissue is minced, then digested with the two enzymes trypsin or collagenase which remove the extracellular matrix holding the cells). Extraction is more difficult if from solid tissues

2) Isolated cells are cultivated and further on proliferated to a gain a sufficient amount of living cells

3) Cells are planted into the scaffold. In ideal state the scaffold should regulate cell adhesion, proliferation, expression of a specific phenotype and extracellular matrix deposition in controlled and predictable fashion. The physical structure of the scaffold may and should control cell functions by regulating the diffusion of nutrients, waste products and cell-cell interactions by providing spatial and temporal control of biochemical cues, whereas scaffold surface chemistry indirectly affects cell adhesion, morphology and subsequent cellular activity by controlling adsorption of ions, proteins and other molecules from the surrounding culture medium. Bioreactors may be used as devices to maintain the environment which is needed.

4) Once the cells are planted into the scaffold, the certain tissue has to be developed. This is achieved by the use of a specific scaffold, growth factors an hormones so as mechanical stimuli (chemical and physical).

5) As soon as the tissue is all grown, it is ready to be implanted into the living body.

The method of tissue engineering is still the subject of internsive research, therapeutic applications mainly focus on the cultivation of tissues from one cell type as the cartilage tissue. Other examples are the synthesis of heart valves and vascular prostheses. The cultivation of skin is already used therapeutically.

Already differentiated cells are mainly taken for tissue engineering. However, stem cells are of great interest due to their ability to differentiate into various tissues and their ability to self-renewal. The term "self-renewal" means a specific form of cell division, which again creates at least one stem cell with the same potential fordifferentiation and replication as the mother stem cell. Stem cells may thus, in contrast to more differentiated cells, proliferate almost indefinitely and differentiate into the respective desired tissue. For this reason, research isunderway to use these stem cells for the therapy of the patient. A particular difficulty is that the stem cells do not differentiate in vitro immediately. The previously successful tissue engineering approaches relate exclusively to tissue from a single cell type. Particularly suitable for the tissue culture is cartilage tissue, as cartilage already exists in the living body (consisting of a single cell type), and is fed only by the synovial fluid. Other important vital tissues, such as Hepatic or renal parenchyma, are so complex in their structure, that in-vitro culture has so far not been successful.

To use the effect of specific organ cells concerning life-threatening diseases, the parenchymal cells are exposed to the bloodstream in dialysis systems. Tissue engineering of functional organs requires alongside the parenchymal cells (eg, hepatocytes) and supporting tissue also blood vessels and bile vessels, even lymph vessels may be grown. Such co-cultures of different cell types is a challenge for the future. Cocultures have so far been carried out for chondrocytes, osteoblasts, endothelial cells and vascular smooth muscle cells. Before these problems are not solved regarding a coculture, tissue engineering will not achieve the broad goals of breeding vital organs. Only then it is possible to replace organs with artificial ones, which are grown from the same (own) cells.

Another important application of tissue engineering is the application in basic research. The just like natural tissue modeled constructs are there to find out about cellular mechanisms. In addition, the methods of the TE enable the production of three-dimensional tissue-like cell constructs in which the effect of pollutants (such. As pesticides), but also the effect of pharmaceuticals can be tested.

In the future a further application might take place in biotechnological production of in vitro meat to bypass factory farming and the associated problems.

File:Principle

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