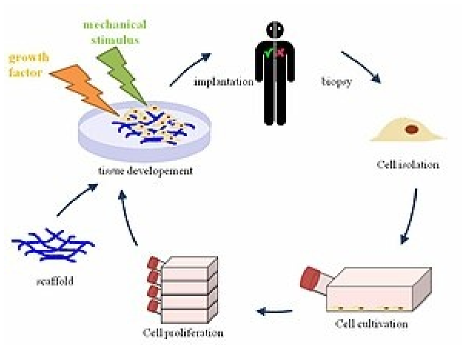
Tissue engineering

Tissue engineering is a multidisciplinary field at the border of medicine, biology, and technical fields, especially material sciences and biotechnology. Its goal is t**he preparation of biologically equivalent substitutes for tissues and possibly organs**. Tissue engineering is usually based on the knowledge of nanotechnology during the construction of the carrier, while the colonization of this carrier with the desired population of cells is based on the knowledge of cellular and molecular biology and tissue physiology.

Artificially created tissue most often comes from the patient's genetic material and is directly engineered to meet their needs.

Principle of tissue engineering



Principle of tissue engineering

1. Cell collection
2. Isolation and subsequent cultivation of cells
3. Seeding and subsequent cultivation of cells on a carrier (scaffold)
4. Implantation of cells into the patient's body

Cell acquisition

From liquid tissues such as blood, cells are usually obtained by centrifugation or apheresis. From solid tissues, extraction is more difficult. The tissue is first digested with trypsin or collagenase enzymes to remove the extracellular matrix to which the cells adhere. Free-floating cells can then be extracted again by centrifugation or apheresis.

Types of cells

Cells are divided into several categories according to their source:

- **Autologous cells** are obtained from the same individual, into which they are subsequently re-implanted. Autologous cells have the lowest risk of rejection by the organism and transmission of pathogens during implantation, but in some cases, suitable cells may not be available (e.g. in genetic diseases). Samples must first be cultured before use. This process is time-consuming, so the autologous solution is not among the fastest. Collection of mesenchymal stem cells from bone marrow and fat is ideal. These cells can differentiate into different types of tissues, including bone, cartilage, fat, and nerves.
- **Allogeneic cells** come from the body of a donor of the same species.
- **Xenogeneic cells** are isolated from individuals of another species. In particular, animal cells are used in experiments aimed at the construction of cardiovascular implants.
- **Syngeneic or isogenic cells** are isolated from genetically identical organisms such as twins or clones.
- **Primary cells** come directly from the organism.
- **Secondary cells** come from a cell bank.
- **Stem cells** are undifferentiated cells with the ability to divide and lead to different forms of specialized cells (differentiation). According to their origin, they are divided into two groups, adult and embryonic stem cells. The collection of embryonic stem cells faces ethical problems, however, these cells are the most suitable for the given purposes.

Tissue carrier - Scaffold

A tissue carrier, or **Scaffold**, is a non-toxic 2D or 3D scaffold-like structure for the organism, which can be used to plant suitable cells in vitro or to support the migration of new cells in vivo. The scaffold serves as a temporary mechanical support for the implanted cells, provides them with a suitable environment for adhesion, growth, and proliferation, and stimulates them to produce their own extracellular matrix. Cells can be cultured on its surface or, thanks to the high porosity of the nanomaterial, they can be embedded directly into its structure. An important feature of the carrier is its ability to biodegrade, i.e. absorbability of the surrounding tissues without the need for its surgical removal.

Materials

Collagen and some polyesters in the form of foams, hydrogels, or nanofibers are most often used in the construction of the carrier. Commonly used synthetic materials include PLA - polylactic acid. This polyester degrades in the human body to form lactic acid, which is naturally degradable. Similar materials are polyglycolic acid (PGA) and polycaprolactone (PCL). Collagen, chitosan, hyaluronic acid, and fibroin are suitable natural materials.

Cultivation

Cultured cells must be provided with an optimal environment, which includes oxygen, pH, humidity, temperature, nutrients, constant osmotic pressure, and possible stimulation with added substances or growth factors.

Implantation

At the appropriate time, the optimally formed tissue is surgically implanted into the patient's body. In the future, tissue engineering could significantly affect the treatment of Parkinson's disease, diabetes, multiple sclerosis, tumors, cardiac diseases (replacement of heart valves), as well as skin replacement after extensive burns and artificial replacement of cartilage, bones, blood vessels, etc.

Links

Related articles

- Nanotechnology in medicine
- Artificial tissues
- Materials in Regenerative Medicine

Sources

- Eberli, D. (Ed). . *Tissue Engineering* [online] . 1. edition. InTech, 2010. 524 pp. Available from <https://www.intechopen.com/books/tissue-engineering>. ISBN 978-953-307-079-7.

- Andrades, Jose A. (Ed). . *Regenerative Medicine and Tissue Engineering* [online] . 1. edition. InTech, 2013. 853 pp. Available from <https://www.intechopen.com/books/regenerative-medicine-and-tissue-engineering>. ISBN 978-953-51-1108-5.

- Kolektiv autorů. *Tissue Engineering : From Wikipedia, the free encyclopedia* [online]. Wikipedia, ©2014. The last revision 2014-11-21, [cit. 2014-11-23]. <https://en.wikipedia.org/wiki/Tissue_engineering>.