Regenerative medicine

Regenerative medicine is the process of creating a repair or replacement for a tissue or organ that has lost function due to age, disease, damage, or birth defects. It is a multidisciplinary field involving tissue engineering, molecular biology and nanotechnology.

Why we need regenerative medicine

- We are currently unable to treat some diseases (Alzhiemer's disease, cystic fibrosis...)
- The human body itself cannot replace damaged tissues (stroke, myocardial infarction, retinal degeneration)
- Lack of tissue and organ donors
- The current population is aging

Development

We can date the beginnings of regenerative medicine to the beginning of the 20th century, when doctors and scientists were primarily concerned with the issue of organ transplantation. Due to the complexity of this issue, transplant research took a relatively long time. The first successful kidney transplant took place in 1954. There were also attempts to transplant bone marrow, which initially ended rather unsuccessfully. Bone marrow research revealed the existence of stem cells, and their discovery started a whole series of experiments trying to fully utilize their potential.

In the 1980s, intensive research was carried out on mesenchymal stem cells found in the bone marrow. Their use includes simple isolation and the possibility of in vitro cultivation with later specialization in the formation of bone, cartilage, fibrous, muscle or fat cells. A significant breakthrough in research is the cloning of the first mammal from the somatic cell of an adult in 1997. It was Dolly the sheep, which received a great response from the general public and started discussions about the ethical aspects of cell therapy. A year later, human embryonic stem cells became the object of research, replacing the mouse cells used up to that time. After this breakthrough, separate human lines of these cells began to be created in research centers around the world. Cloning human embryos to obtain stem cells was first legalized in England in 2001. In the fall of that year, a human embryo was cloned for the first time by an American company. In 2006, Japanese biologist Shinya Yamanaka and the team of Gustav Mostoslavsky significantly pushed the boundaries of what was possible at the time thanks to research into induced pluripotent stem cells, which they obtained by inserting transcription factors into cells using a quartet of genetically modified viruses. The advantage of the cells obtained in this way was their production even without a human embryo, as well as the potential ability to differentiate into almost any type of cell. However, the cells showed a greater propensity for tumor growth and deterioration of coordination due to DNA damage during gene insertion. However, the rate of these defects decreased significantly after the improvement of the gene insertion method. Currently, scientists are looking for a way to retroactively remove the artificially inserted gene to obtain a pure line. It is these cells that could be a hope for patients suffering from diabetes or Parkinson's disease in the future.

In 2008, a team from the Institute of Experimental Medicine of the Academy of Sciences of the Czech Republic led by Professor Eva Syková and the Research Institute of Animal Production managed to achieve the same result as the Japanese researchers within four months. A cell taken from the skin was altered by scientists using genetic manipulation, returning it to the initial state of a universal stem cell. "The main benefit is the fact that this method bypasses the patient's immune barrier. All stem cells taken from embryos to date cause a rejection reaction in the recipient's organism, which must be suppressed," says Professor Eva Syková. According to her, it is also an advantage that the stem cell prepared by the new procedure does not tend to turn into a tumor. New technology will make it possible to study the causes of diseases and search for treatment procedures. Scientists who are active within the Center for Cell Therapy and Tissue Replacement, thus, they became the first in the Czech Republic to join several global laboratories managing this procedure. In 2008, human embryo cloning research continued. Legislation regarding stem cell research has also moved significantly in some developed countries.

Research

Czech Republic

The level of stem cell research is comparable to other developed countries. The Academy of Sciences of the Czech Republic, the specialist workplaces of Charles University and the Institute of Clinical and Experimental Medicine, who cooperate with each other, participate in the research. The research is financed from the state budget and is legislatively treated by the 2006 law, which allows research on embryonic cells from excess or damaged eggs and strictly prohibits the cloning of human embryos and the genetic manipulation of the human genome.

USA

In the US, regenerative medicine research has had a difficult journey. In 2001, President George Bush banned state funding of embryonic stem cell research. This ban was lifted only in 2009 by President Barack Obama, thus giving scientists the opportunity to continue research even at workplaces financed from the state budget.

Usage

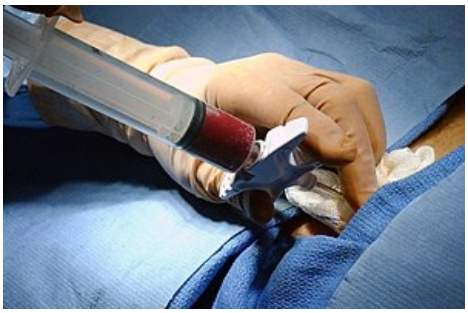
Hematopoietic stem cell transplantation

Since the 1980s, stem cells from bone marrow and recently from umbilical cord blood are used to treat patients with hematological malignancies such as leukemias and lymphomas. Chemotherapy is used to eliminate tumor stem cells. Cytostatic drugs do not differentiate between leukemic and healthy hematopoietic stem cells in the bone marrow. A healthy stem cell transplant restores the stem cells lost during treatment.

Future

Type 1 diabetes mellitus

A clinical trial underway at the University of Florida is investigating how autologous cord blood stem cell infusions administered to pediatric patients with type 1 diabetes will compare to standard insulin therapy. Preliminary results show that these infusions are safe and can slow the loss of insulin production in children with type 1 diabetes



Bone marrow biopsy

- Treatment of diseases and injuries that cannot currently be treated. We are talking about Parkinson's disease, Alzheimer's disease, amyotrophic lateral sclerosis, muscular dystrophy and genetic disorders.
- New functional tissues and organs created from the patient's own cells.
- Restoration of damaged tissues
  - Musculoskeletal system - cartilage, bones, muscles, tendons
  - Cardiac tissue after a heart attack
  - Nervous tissues of the brain and spinal cord
  - Skin
  - Retina and cornea

Links

Related Articles

- Tissue engineering

External links

- ŠEFC, Luděk. *Regenerativní medicína* [online]. [cit. 2014-11-28]. <http://patofyziologie.lf1.cuni.cz/file/437/Regenerativni%20medicina%202013.pdf>.
- KUBINOVÁ, Šárka. *Biomateriály v regenerativní medicíně* [online]. [cit. 2014-12-02]. <https://moodle.lfhk.cuni.cz/moodle2/login/index.php>.
- KOLEKTIV, Autorů. *Regenerative medicine* [online]. [cit. 2014-12-03]. <https://en.wikipedia.org/wiki/Regenerative_medicine>.