Stem cells, about cells with a future

Biomedical research currently receives much attention from business, scientists and media. Major results are claimed daily and developments are moving fast. Stem cell research is a biomedical area now discussed by many. But what are stem cells exactly? What use are they? What can we expect of them in the future? Many questions. Time to learn more about them.

First of all stem cells can be found in most tissues of the body but have not generally been assigned a specific task. They are therefore different from cells like, for example, muscle, nerve and heart cells. Stem cells could be compared to pizza dough: they can divide either into two, four or eight identical pieces, but that does not determine what kind of cell (or pizza) is going to be made. However, once the cell has developed multiple nuclei and muscle proteins (or the pepperoni has been piled on), a skeletal muscle fiber (or a pepperoni pizza) is in preparation. A white blood cell (or an all-veggie pie) is no longer an option. For cells, this is known as 'specification' or 'terminal differentiation' which means they have acquired their final identity and can no longer divide.

That is the principle of how stem cells work. In the beginning they can grow into any type of cell of the body. As they develop, what they can turn into becomes more and more restricted. As soon as the basic characteristics of a muscle cell are determined, the cell can no longer turn around and form a nerve cell or a blood cell.

Cells that can grow into any type of cell

There are different types of stem cells. The best example of a stem cell is a fertilised egg: it can grow into any type of cell of the whole body as well as all the tissues needed to attach it to its mother, like the placenta. In the end a complete human being will develop from it! It takes about five to six days for a fertilised egg to divide enough times to form a little clump of cells in which not all cells are identical. The outer cells can then only become the supporting cells like the yolk sac. The inner cells all have the same characteristics, and do not yet have a specific task in the body just like the pieces of pizza dough. They can form all cells of the fetus and ultimately of an adult individual. They are called 'embryonic stem cells'.

Life saving in the future?

Embryonic stem cells are isolated from embryos that left over from in-vitro fertilisation treatments. They can be used for scientific research but only when the parents have given permission to do so and when an ethical committee has approved the research question. There are no patients anywhere in the world involved in clinical trials or treatments with embryonic stem cells.

Research with embryonic stem cells is subject to much discussion. Opponents criticize the research because isolation of embryonic stem cells means destroying an embryo that could have become a baby. Advocates emphasize that the embryo would have been destroyed anyway and that, in the future, embryonic stem cells could be used for treating chronic and sometimes fatal diseases.

Treatment with adult stem cells

Many organs in adults contain stem cells. These could be compared with pizza bases already covered in tomato sauce. Adult stem cells are what we call 'committed': they can grow into different types of cells but not all. A good example are adult stem cells in the bone marrow. They

continuously make new erythrocytes (red blood cells), leukocytes (white blood cells) and platelets.

Transplantations with some types of adult stem cells have been successful for more than 30 years. Leukaemia patients, for example, are irradiated or undergo chemotherapy to remove all (malignant) stem cells in their bone marrow. They then receive new stem cells from the bone marrow of a donor to restore their immune system and provide them with healthy blood cells.

Stem cells are also present in the umbilical cord of newborn babies. These stem cells can, like stem cells from the bone marrow, be used in the treatment of diseases, like leukaemia, anaemia and storage disorders. Because the umbilical cord only contains a small volume of blood however, relatively few stem cells can be harvested from it. To treat an adult patient multiple cord blood donors are usually needed.

Stem cells from the bone marrow and from the umbilical cord can be stored in special stem cell banks. Current research investigates whether these blood stem cells can form other cell types, than just blood. There is evidence that they can turn into bone, cartilage or fat cells but there is no strong evidence that they can become anything else.

Future applications

What the future will bring is hard to predict. People expect a great deal from stem cells. Current research is investigating the potential of stem cells for treatment of cardiovascular diseases, for example after a heart attack, or ischemic conditions of the lower leg. The possible applications in the treatment of burns and scalds (using skin stem cells), diabetes and Parkinson's disease are under investigation. Adult stem cells from a person's own body would be the best and safest treatment but it is not clear whether or not adult stem cells will be able to repair or replace damaged tissues other than those close to their origin.

Scientists are also trying to understand why embryonic stem cells have this unique capacity to become everything. Their goal would then be to try and manipulate adult stem cells to turn them back into cells with no specific task in the body, just like embryonic stem cells. If these scientists succeed, maybe embryonic stem cells would no longer be needed. It would then just be a question of turning adult stem cells into the right cell for therapy. Whichever way the research goes, there is only one guarantee: that a lot of work has to be done!

Further information

This article is the English version of the Dutch brochure 'Stamcellen, over cellen met toekomst', that was released by the Erfocentrum to inform the Dutch public about biomedical research. To read the Dutch or English digital version, please visit: www.biomedisch.nl/stamcellen

Contact:
Eelco Soeteman
e.soeteman@erfocentrum.nl

www.erfocentrum.nl
www.biomedisch.nl

With cooperation of prof. dr. Christine Mummery, professor of developmental biology of the heart at the Hubrecht Laboratory, Utrecht.

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