

About stem cells

1. What are stem cells?

Stem cells are cells that are able to divide to produce copies of themselves as well as producing different specialised types of cell in the body such as muscle cells, red blood cells or insulin-producing 'beta' cells which are found in the islets of the pancreas. They are present as '**embryonic**' stem cells in the growing embryo and as '**adult**' stem cells throughout a person's entire life.

Different categories of stem cells have different purposes and therefore different characteristics.

Embryonic stem cells

These are stem cells which are found in four to five-day old embryos, and have the potential to turn into any of the hundreds of cell types that make up the human body. Because of their unlimited ability to replicate and their **potential to form any cell type**, some scientists think that in the future embryonic stem cells could be used as a treatment for disease or injury.

These cells are taken from embryos that are left over from IVF (in vitro fertilisation) treatment. More embryos are created during this treatment than can be implanted and those not used can be frozen for future use, donated to other people, donated to medical research or discarded. Any embryos that are used for research purposes can be grown for only 14 days, after which they must be destroyed.

Adult stem cells

These are stem cells which are found in various parts of the body and act as a kind of repair system, replenishing the body with a natural turnover of new and healthy cells and replacing damaged tissue after injury.

Most adult stem cells are '**tissue-specific**', meaning that they are not able to turn into all types of cells because they have already begun to '**differentiate**'. This means that they have moved

further along the developmental path towards becoming a particular type of cell and cannot turn back.

These cells can be isolated from a tissue sample obtained from an adult or child. For example bone marrow contains stem cells that are capable of becoming all varieties of blood cells. Some types of adult stem cells are very difficult to find in the body, and researchers have had limited success in finding or collecting adult stem cells which would be able to form the insulin-producing beta cells of the pancreas.

Human-hybrid embryonic stem cells

Currently there are not enough high-quality embryos available for research. Therefore, scientists have developed a way to generate new forms of embryos that are called human-hybrid embryos and there are several kinds of these. The type that British scientists are most interested in using are called **human-animal admixed embryos**, also known as cybrids.

These are formed by transferring the DNA of a human cell into an animal egg cell which has had almost all of its own DNA removed. The animal cell acts as a shell for the human nucleus and the resulting admixed cell will contain only 0.1 per cent animal DNA, which is restricted to small components in the shell called mitochondria.

Other types of human-hybrid embryos that scientists are interested in using are **human transgenic embryos**, which are made by injecting a segment of animal DNA into a human egg to create a mixed cell.

In all of these cases the resulting cells are then treated so that they behave similarly to a newly fertilised egg and begin to produce an embryo which provides a source of stem cells. As with all research embryos, these can be grown only for 14 days before they must be destroyed. ▶

2. Why do scientists think stem cells could help people with diabetes?

They could supply a source of cells for research

Stem cells could provide a valuable source of cells for research to help us better understand how conditions like diabetes develop and how best to treat them. Currently, limited availability of cells for research hampers scientists' basic understanding of how diabetes develops.

They could replace missing insulin-producing cells

In Type 1 diabetes the body's immune system mistakenly attacks the insulin-producing beta cells which are found in the islets of the pancreas. This means that someone with Type 1 diabetes will need to take insulin injections for life. One day it may be possible to use stem cells to replace the attacked insulin-producing beta cells in people with Type 1 diabetes meaning that they can produce their own insulin again. However, transplanted stem cells may still need to be protected from this 'autoimmune' attack so that the transplanted cells are not destroyed again. People who have this treatment may need to take anti-rejection medication for life to ensure their body does not reject the implanted tissue.

In Type 2 diabetes, insulin resistance occurs when the body is less able to respond to the insulin it

produces, therefore adding in extra insulin-producing cells may not be beneficial. However, as the beta cells in someone with Type 2 diabetes can wear out over time, it is possible that stem cell-derived beta cell transplants may be helpful for some people with Type 2 diabetes.

They could replace other cells damaged by diabetes

For people with any form of diabetes another therapeutic use of stem cells could be to generate replacement tissue for organs damaged by the complications of diabetes. For example stem cell-derived retinal cells could be used to improve vision in people with diabetes-related retinopathy.

They could 'reboot' the faulty immune system

Another use for stem cells might be to replace the immune system in people at risk of developing Type 1 diabetes before the autoimmune attack destroys their insulin-producing cells, therefore preventing Type 1 diabetes. This area of research is at a very early stage, and the approach has not yet been proven in animal models of diabetes, or indeed in humans.



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