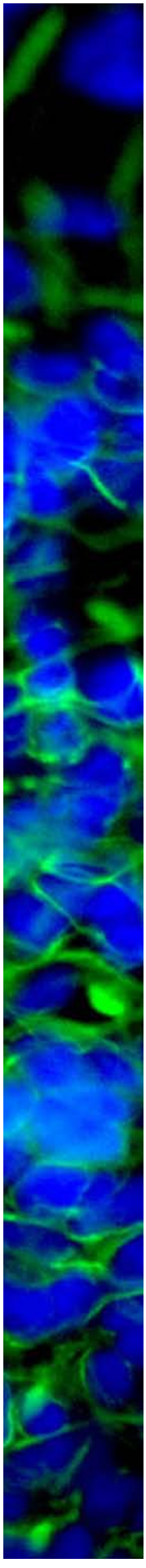


Fact Sheet 7

Induced Pluripotent Stem Cells (iPS cells)

Stem cell science is an extremely fast moving field of research with new breakthroughs being reported almost daily. This swiftly changing landscape has seen many different stem cell types and technologies capture popular imagination including embryonic stem cells (ES cells), tissue stem cells and cord blood stem cells. Currently attracting a lot of public attention are some recent breakthroughs in the areas of reprogramming and in particular the discovery of a way to make a new stem cell type which have been named induced pluripotent stem cells (iPS cells).

Reprogramming

The term reprogramming is often used to refer to techniques developed by scientists to change the developmental potential or fate of a cell. The objective of reprogramming is to take a defined cell from the body (somatic cell), such as a skin cell, and convert it to more primitive stem cell which would be capable of developing into another cell type such as a heart or blood cell.

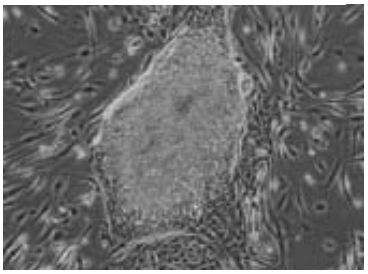
Currently there are two different approaches to reprogramming being investigated by scientists around the world to make stem cells: somatic cell nuclear transfer (SCNT) which is covered in the ASCC's Fact Sheet No.4; and the creation of iPS cells.

Both types of reprogramming are of great interest to scientists as they represent ways to potentially create disease specific stem cells to study particular diseases in the laboratory or patient specific stem cells that could provide replacement cells to treat a patient which would not be rejected by the immune system. However, both types of reprogramming research are in the very early stages and are many years away from a therapeutic use.

Induced Pluripotent Stem Cells

In November 2007[1,2], a significant development occurred when scientists announced they had developed a new technology to cause mature human cells to resemble pluripotent stem cells similar in many ways to hESCs by altering the gene activity within the cell. These reprogrammed cells are referred to as induced pluripotent stem (iPS) cells.

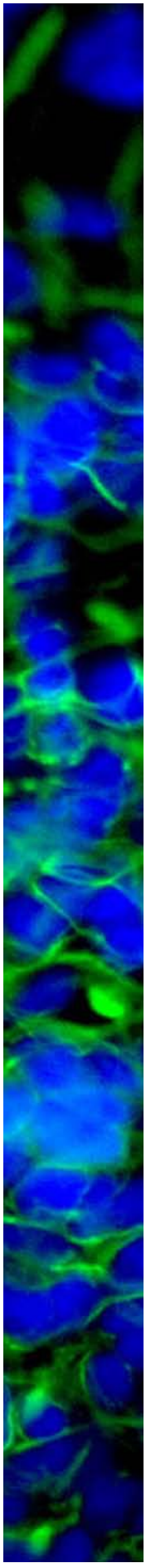
Figure 1: iPS Cell Colony



Initially iPS cells were generated using viruses to genetically engineer mature cells to achieve a pluripotent status. The purpose of the virus is to insert reprogramming genes into mature cells such as skin cells. The cells are then grown in the laboratory for several weeks after which a small number of iPS cells begin to appear. However technologies for reprogramming cells are moving very quickly and researchers are now investigating the use of new methods that do not use viruses which can cause permanent and potentially harmful changes in the cells.

[1] Yu J, Vodyanik MA, Smuga-Otto K, Antosiewicz-Bourget J, Frane JL, Tian S, Nie J, Jonsdottir GA, Ruotti V, Stewart R, Slukvin II, Thomson JA. Induced pluripotent stem cell lines derived from human somatic cells. *Science,* 2007, vol 318, pp1917-20.

[2] Takahashi K, Tanabe K, Ohnuki M, Narita M, Ichisaka T, Tomoda K, Yamanaka S.. Induction of pluripotent stem cells from adult human fibroblasts by defined factors. *Cell*. 2007, vol 131(5), pp861-72.



What could iPS cells offer?

If they are able to be made safely, and on a large scale, iPS cells could possibly have the same therapeutic potential as any form of pluripotent stem cell, providing a source of cells for replacement and regeneration after damage due to disease, injury, congenital (birth) defects or normal ageing.

This technology also allows scientists a new method of creating disease specific cells for research by creating iPS cells from the adult cells of a patient with a genetic disorder, such as Huntington's disease. Studying these disease specific stem cells may improve our understanding of certain diseases, and assist in the development and testing of new drugs.

iPS cell research also has the potential to produce patient specific, genetically identical, stem cells that would be recognised as self by the patient's immune system and not rejected.

For more information on the progress of stem cell research in treating patients please review the ASCC's Patient Handbook.

Will iPS cells replace the need for human embryonic stem cells?

The discovery of iPS cells has been celebrated among scientists, ethicists and politicians alike and one day may potentially eliminate the need for embryos in stem cell research or therapy. However much is still unknown about these cells and more research needs to be done into iPS cells to discover if they will offer the same research value as embryonic stem cells and if they will be as useful for therapy.

Safety is the major concern at this point as the cells are made using various genetic engineering technologies making them unsuitable for use in humans. However, much progress is being made towards safer mechanisms to make iPS cells. Like embryonic stem cells, iPS cells can form every cell in the body including cancerous cells. Therefore the same stringent requirements on ensuring that cells are fully differentiated before being used in a therapy would apply to iPS cells and hESCs.

What is required is the continuation of well regulated research in Australia consistent with current legislation governing the responsible use of human embryos[3] and gametes in research and guidelines such as the *National Statement on Ethical Conduct in Human Research (2007)*. In addition, research involving iPS cells also has to be conducted in accordance with the *Gene Technology Act 2000* and overseen by the Office of the Gene Technology Regulator due to the genetic modification that is required.

[3] *Research Involving Human Embryos Act 2002* and the *Prohibition of Human Cloning for Reproduction Act 2002* as found at http://www.comlaw.gov.au