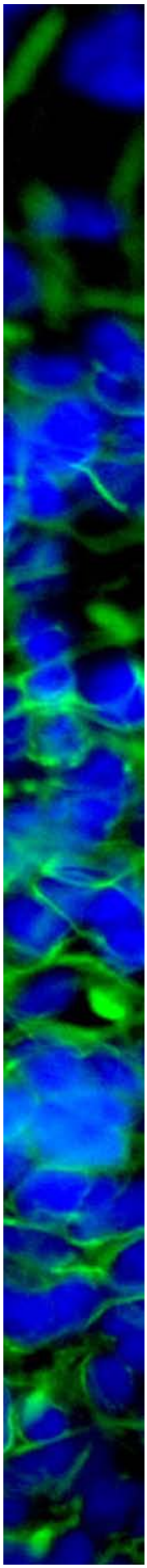


Fact Sheet 4
Therapeutic Cloning (Somatic Cell Nuclear Transfer)

What is therapeutic cloning?

Therapeutic cloning refers to the removal of a nucleus, which contains the genetic material, from virtually any cell of the body (a somatic cell) and its transfer by injection into an unfertilised egg from which the nucleus has also been removed. The newly reconstituted entity then starts dividing. After 4-5 days in culture, embryonic stem cells can then be removed and used to create many embryonic stem cells in culture. These embryonic stem cell 'lines' are genetically identical to the cell from which the DNA was originally removed.

Therapeutic cloning is also known as somatic cell nuclear transfer (SNCT) as the term cloning is frequently misunderstood by the general public. The word 'cloning' more often conjures up thoughts and beliefs about reproductive cloning.

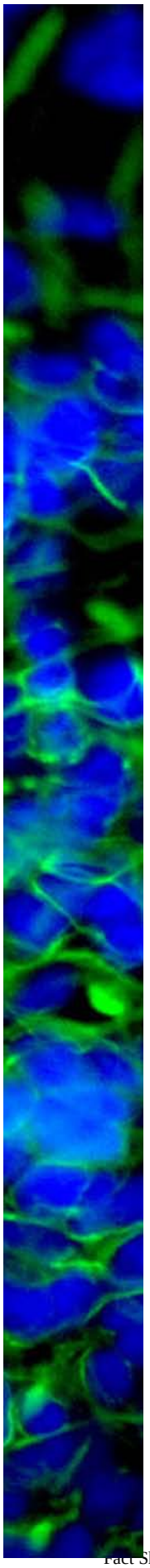
Reproductive cloning is if a newly formed embryo, resulting from a therapeutic cloning procedure, were transferred into the womb of a woman, it could theoretically, develop into a fetus. This technique has been used to clone agricultural animals, endangered species and recently domestic pets and primates, but has not been proven in humans. The scientific community overwhelmingly rejects the use of therapeutic cloning for the purposes of human reproductive cloning. Reproductive cloning is illegal in Australia and in many other countries.

While the procedure of therapeutic cloning employs aspects of cloning technology, researchers today are interested in therapeutic cloning as a means of deriving human embryonic stem cell lines for use in research and, ultimately, therapy. Therapeutic cloning has been legal in Australia since 2006 under the *Prohibition of Human Cloning for Reproduction and the Regulation of Human Embryo Research Amendment Act 2006.* Any Australian researchers wishing to use therapeutic cloning must apply to the National Health & Medical Research Council (NHMRC) for a licence.

What is special about therapeutic cloning?

The capacity of therapeutic cloning to re-program adult nuclei is extraordinary and unique. Cells of particular tissues generally express a characteristic set of genes. Whether they are primitive stem cells, fully-differentiated (i.e. mature) cells, or something in between these extremes. Particularly for more mature cells, the tissue-specific patterns of gene expression are quite stable through many rounds of cell division.

Upon transfer to an enucleated egg, the adult nucleus becomes re-programmed in the environment of the egg. That is, genes that were not used before (switched off) become reactivated. A poorly-understood process, re-programming involves dramatic changes in the pattern of genes which are active in the nucleus. Instead of the adult nucleus causing the egg to behave like an adult cell, the egg causes the nucleus to go backwards along a differentiation sequence, resulting in an embryonic type cell. As a result of therapeutic cloning, the previously unfertilised egg takes on the properties of a fertilised egg and begins the first stages of development into an embryo.



What is known about the embryos resulting from therapeutic cloning?

In broad terms, embryos arising from therapeutic cloning are the same as embryos from fertilisation of an egg by a sperm. In agricultural research, therapeutic cloning has been used to create embryos in the laboratory which have been transferred into animals and given rise to offspring. 'Dolly' the sheep was born as a result of this procedure.

However, there are also differences between a normally fertilised egg and one produced by therapeutic cloning, which are not generally understood. In animal studies clones appear to have increased abnormality and decreased pregnancy rates. For example, despite being relatively young for a sheep, which can live to 11 or 12 years of age, Dolly died prematurely at the age of six years, showing signs of arthritis and lung infection. Other than the major ethical concerns, this is a fundamental reason why reproductive cloning should not be performed on humans.

Research involving therapeutic cloning and its potential application

While the scientific community overwhelmingly rejects the use of THERAPEUTIC CLONING for reproductive cloning, it would provide an invaluable tool for basic research.

As reported in *Nature* in November 2007 scientists successfully extracted stem cells from nonhuman cloned primate embryos. Although it is a highly significant achievement it must be considered that it took 304 eggs to produce two successful embryonic stem cell lines.

In January 2008 a Californian company Stemagen reported it had successfully cloned a human blastocyst, an early stage embryo. The Stemagen embryos were the first to be made with human adult skin cells through therapeutic cloning, however they did not attempt to produce stem cell lines, focusing their attention on extensive genetic tests to prove the identity of the cloned embryos.

Researchers regard therapeutic cloning as an effective method for deriving human embryonic stem cells with specific characteristics, about which a great deal remains to be known and understood. The promise of therapeutic cloning is that it will be an effective way to derive embryonic stem cells which can then be used for the development of patient- and disease-specific cell-based therapies as well as the production of stem cells with specific disease characteristics for research purposes.

The use of a patient's own cells for tissue replacement through therapeutic cloning overcomes the problem of immune rejection that is a major complication of tissue transplantation today. Embryonic stem cells derived by nuclear transfer may, in the future, be used to treat diseases including diabetes, heart disease and Parkinson's disease.