



Inevitable tragedy from human cloning

1 Introduction

Maverick scientists claim that the first cloned humans may soon be born. But new evidence reinforces the dangers of human cloning.

2 What the article said

Research published in *Nature Genetics* showed a high rate of abnormalities among cloned animals.¹ Cloned cows had flaws in nine of 10 genes on their X chromosome. The scientists predicted that because of gene expression problems, only 1 per cent of cloned human embryos would survive to birth, and a high percentage of those born would die soon after.

3 Ethical analysis

This is just one of many problems associated with cloning by nuclear transfer into enucleated eggs, in that DNA is incorrectly 'imprinted'. Imprinting refers to a specific pattern of DNA modification – addition of methyl groups to certain DNA residues to silence a gene.

Imprinting means that when two copies of a particular gene are inherited, one from the mother and the other from the father, one is inactivated so that only one gene ends up being expressed. This has particular significance for the sex chromosomes.

The *Nature Genetics* research focuses on genetic damage on the X chromosome which is one of the chromosomes involved in sex determination.

In humans the sex determination system works like this: females have two X chromosomes and males have one X and one Y chromosome. The X chromosome has a short region of similarity to the Y²; but most genes on the X have nothing to do with male-female differences. They are a collection of genes for a range of characteristics including bloodclotting, muscle function and vision. Defects in these genes lead to haemophilia, muscular dystrophy and colourblindness respectively.

Were it not for imprinting, the presence of these genes on two X chromosomes in females would lead to problems in gene expression. Because females are XX (two Xs), they possess double the level of all X genes. As a result, females could produce an 'overdose' of gene products, that is proteins made by the genes, and this excess of particular proteins would lead to all manner of biochemical and hence physiological dysregulation. But this problem is circumvented by imprinting, which shuts down one or other of the female X chromosomes, so that only one set of genes is active and thus only one correct 'dose' of proteins is manufactured. Which X chromosome is

¹ "Human clones by year's end spawn 'freak' fears" *The Australian* 28/5/02, p3

² This part of the Y is not the male-determining part of that chromosome.



suppressed varies from cell to cell, but the important point is that only one X chromosome is active.

However, in cloning by nuclear transfer, this sort of imprinting does not occur correctly, leading to serious errors in gene expression. Furthermore, there may be other forms of the imprinting problem with equally deleterious results. At this stage, in studies on animal cloning there is no known way to address this problem and it may remain a typical outcome of cloning experiments.

Current attempts to clone human beings will also be subject to this phenomenon resulting in a plethora of genetic and physiological damage. There can be little doubt that the consequences to the people involved will be tragic and destructive.