

# LIVESTOCK CLONING

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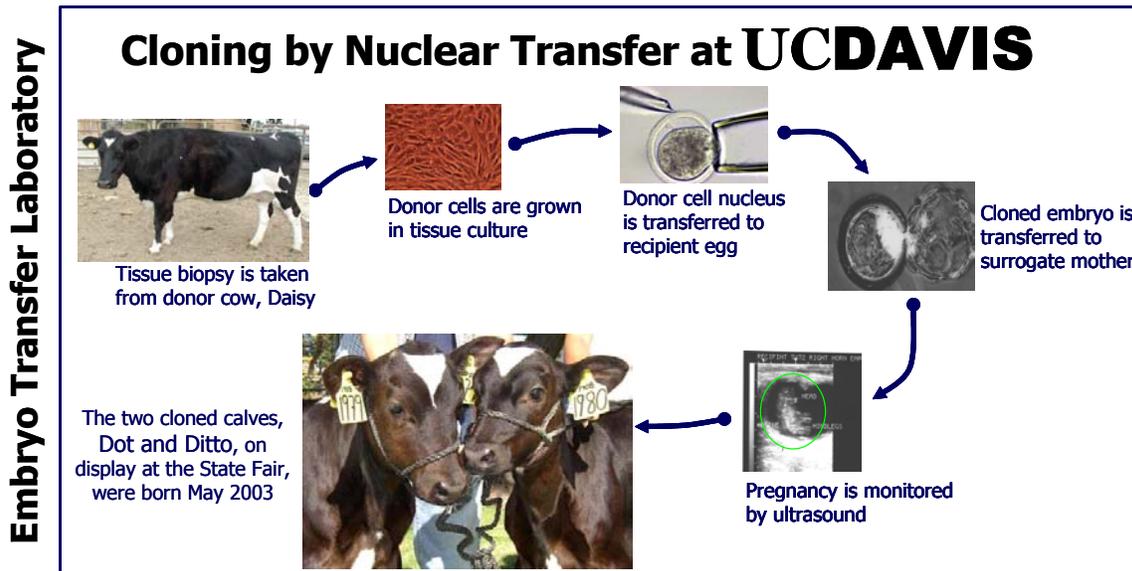


## How is livestock cloning accomplished?

A clone is an organism that is descended from, and genetically identical to, a single common ancestor. Animals can be cloned by embryo splitting or nuclear transfer. Embryo splitting involves splitting the multicellular embryo at an early stage of development to generate “twins”. This type of cloning occurs naturally and has also been performed in the laboratory with a number of species.

Cloning can also be achieved by nuclear transfer where the genetic material in the nucleus from one cell is placed into a “recipient” unfertilized egg that has had its genetic material (nucleus) removed by a process called enucleation. It is then necessary to activate the egg to start dividing as if it had been fertilized. In mammals the egg must then be artificially placed into the womb of a surrogate mother where it will grow until birth. The first mammals cloned by this process were born during the mid 1980s, almost 30 years after the initial successful experiments with frogs. Numerous mammalian species have been cloned via this procedure, including mice, rats, rabbits, pigs, goats, sheep, cattle, horse, and rhesus monkeys. There are no documented cases of human cloning.

DOLLY the sheep was the first animal to be cloned from an adult cell. In this case, the genetic material in the nucleus was transferred from an adult somatic (non-egg) cell that had been cultured in the laboratory. This process, which allows cloning to be performed on an adult animal whose traits are well known, is called somatic cell nuclear transfer. A diverse range of adult tissues have been used to successfully clone a variety of species including cattle, pig, horse, cat, rabbit, goat, and fish.



The two calves, DOT and DITTO, were produced at UC Davis from adult cells taken from the mature cow, DAISY (pictured above).

# LIVESTOCK CLONING *(continued...)*

## Do clones develop normally ?

Currently the cloning procedure is inefficient because the percentage of adult cell nuclei that develop into live animals after transfer into the enucleated egg cell is very low. High rates of pregnancy loss have been observed at various times after placement of the eggs containing the adult cell nuclei into recipient animals. Various abnormalities have been observed in cloned cows and mice after birth and this appears to be at least partially dependent on the type of tissue from which the transferred nucleus was derived. The reasons for the low efficiency of cloning by nuclear transfer are not known. Current ideas are that it might be related to the fact that the reprogramming, which must occur in the nucleus from the somatic (non-egg) cell, is not sufficient. The genetic material in the nucleus goes from directing the production of an adult somatic cell to directing the production of a whole new embryo, two very different processes.

Several studies examining the composition of products derived from animal clones to those derived from non-cloned cattle found that there were no obvious differences in the composition of milk or meat from cloned cows. The main underlying food safety concern with clones is whether the nuclear reprogramming that occurs during the cloning process has any influence on the composition of animal food products. Producers of cloned animals are currently observing a moratorium on the sale of these animals into the food chain while waiting for guidance from the U.S. Food and Drug Administration (FDA) on the marketing of these animals. The FDA's Center for Veterinary Medicine is ultimately responsible for evaluating the food safety and animal health implication of cloning, as well as its environmental impact.

## Why are animals being cloned ?

Cloning involves the production of genetically identical individuals and is not genetic engineering *per se*, but there is a logical connection between the two technologies. Cloning offers the opportunity to make genetically engineered or transgenic animals more efficiently from cells that have been genetically modified in the laboratory. The main application of livestock cloning will be the production of animals from cells that have been genetically engineered for the purposes of human medicine. The first genetically engineered (transgenic) mammalian clones were sheep born in 1997 carrying the genetic information to make the human clotting factor IX in their milk, which is an important therapeutic treatment for hemophiliacs. Since that time cloned, genetically engineered animals have been reported in other species including goats that produce alpha-1 antitrypsin, a cystic fibrosis therapeutic treatment, in their milk. "Xenotransplantation-friendly" pigs, lacking the cell-surface protein that triggers organ rejection, are also being researched for use in transplantation surgery. In the future it may be possible to produce agricultural livestock with increased disease resistance or improved milk composition. Cloning from frozen tissue samples is also being used for the preservation of rare and endangered species such as the Banteng, and even extinct species such as the Asiatic cheetah.

## Internet Resources

**Cloning website** from the Roslin Institute (the makers of Dolly)

<http://www.roslin.ac.uk/public/cloning.html>

**Are the milk and meat from cloned cows safe to eat?**

[http://animalscience.ucdavis.edu/animalbiotech/Outreach/Are\\_the\\_milk\\_and\\_meat\\_from\\_clones\\_safe\\_to\\_eat.pdf](http://animalscience.ucdavis.edu/animalbiotech/Outreach/Are_the_milk_and_meat_from_clones_safe_to_eat.pdf)

The FDA's Center for Veterinary Medicine's risk assessment on livestock cloning

<http://www.fda.gov/cvm/Documents/CLRAES.pdf>