

# Cloning

## What is cloning

- Cloning is the process of taking genetic information from one living thing and creating identical copies of it
- The term cloning describes a number of different processes that can be used to produce genetically identical copies of a biological entity
- The copied material is called a clone
- Clones are organisms that are exact genetic copies. Every single bit of their DNA is identical
- Researchers have cloned a wide range of biological materials, including genes, cells, tissues and even entire organisms, such as a sheep

- Nature has been doing the cloning for millions of years.
- For example;
  - identical twins have almost identical DNA
  - asexual reproduction in some plants and organisms can produce genetically identical offspring
- organisms such as bacteria (and some plants) create offspring that are genetically identical to the parent
- Modern genetic technology can also be used to create clones

## Natural Cloning

- Natural clones, also known as identical twins, occur in humans and other mammals. These twins are produced when a fertilized egg splits, creating two or more embryos that carry almost identical DNA. Identical twins have nearly the same genetic makeup as each other, but they are genetically different from either parent

*There are three types of cloning:*

- Gene cloning: Gene cloning produces copies of genes or segments of DNA
- Reproductive cloning: Reproductive cloning produces copies of whole animals
- Therapeutic cloning: Therapeutic cloning produces embryonic stem cells for experiments aimed at creating tissues to replace injured or diseased tissues

## Types of artificial cloning

- There are three different types of artificial cloning: gene cloning, reproductive cloning and therapeutic cloning

## Reproductive cloning

### *Somatic Cell Nuclear Transfer*

Somatic cell nuclear transfer (SCNT), also called nuclear transfer, uses a different approach than artificial embryo twinning, but it produces the same result: an exact genetic copy, or clone, of an individual. This was the method used to create Dolly the Sheep.

# What does SCNT mean?

## Somatic cell

- A somatic cell is any cell in the body other than sperm and egg, the two types of reproductive cells. Reproductive cells are also called germ cells. In mammals, every somatic cell has two complete sets of chromosomes, whereas the germ cells have only one complete set.

## Nuclear:

- The nucleus is a compartment that holds the cell's DNA. The DNA is divided into packages called chromosomes, and it contains all the information needed to form an organism. It's small differences in our DNA that make each of us unique.

## Transfer

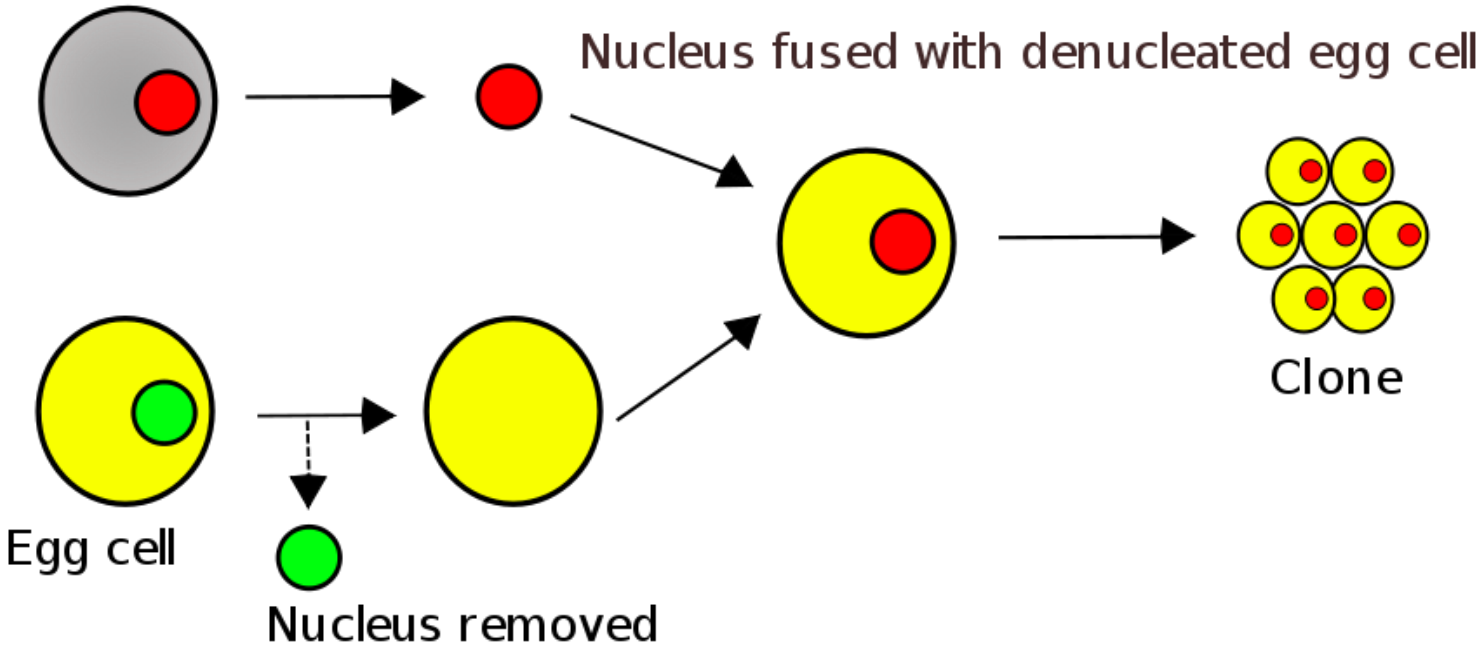
- In reproductive cloning, researchers remove a mature somatic cell from an animal that they wish to copy (example; skin cell)
- Somatic cell is any cell except for reproductive cells i.e. egg and sperm
- Then transfer the DNA of the donor animal's somatic cell into an egg cell, that has had its own DNA-containing nucleus removed
- The egg is allowed to develop into an early-stage embryo in the test-tube and then is implanted into the womb of an adult female animal.



## Transfer

- The adult female gives birth to an animal that has the same genetic make up as the animal that donated the somatic cell.
- This young animal is referred to as a clone.
- Reproductive cloning may require the use of a surrogate mother to allow development of the cloned embryo, as was the case for the most famous cloned organism, Dolly the sheep

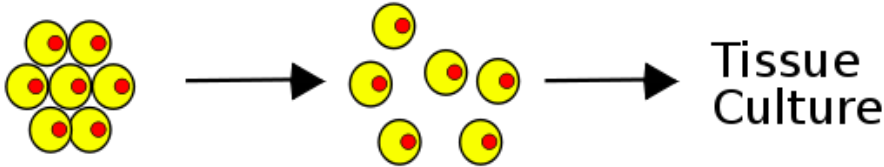
Somatic body cell with desired genes

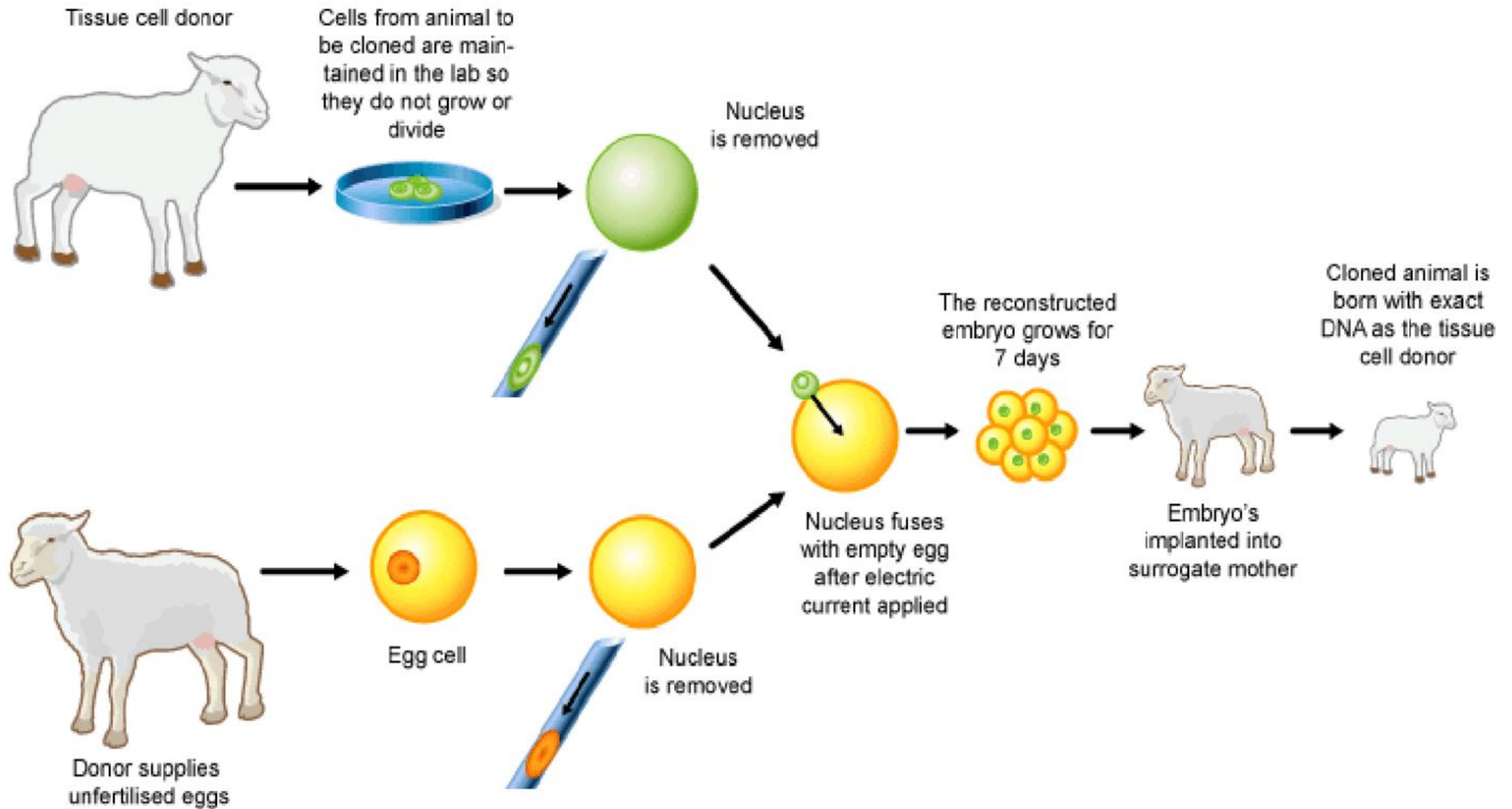


REPRODUCTIVE CLONING



THERAPEUTIC CLONING

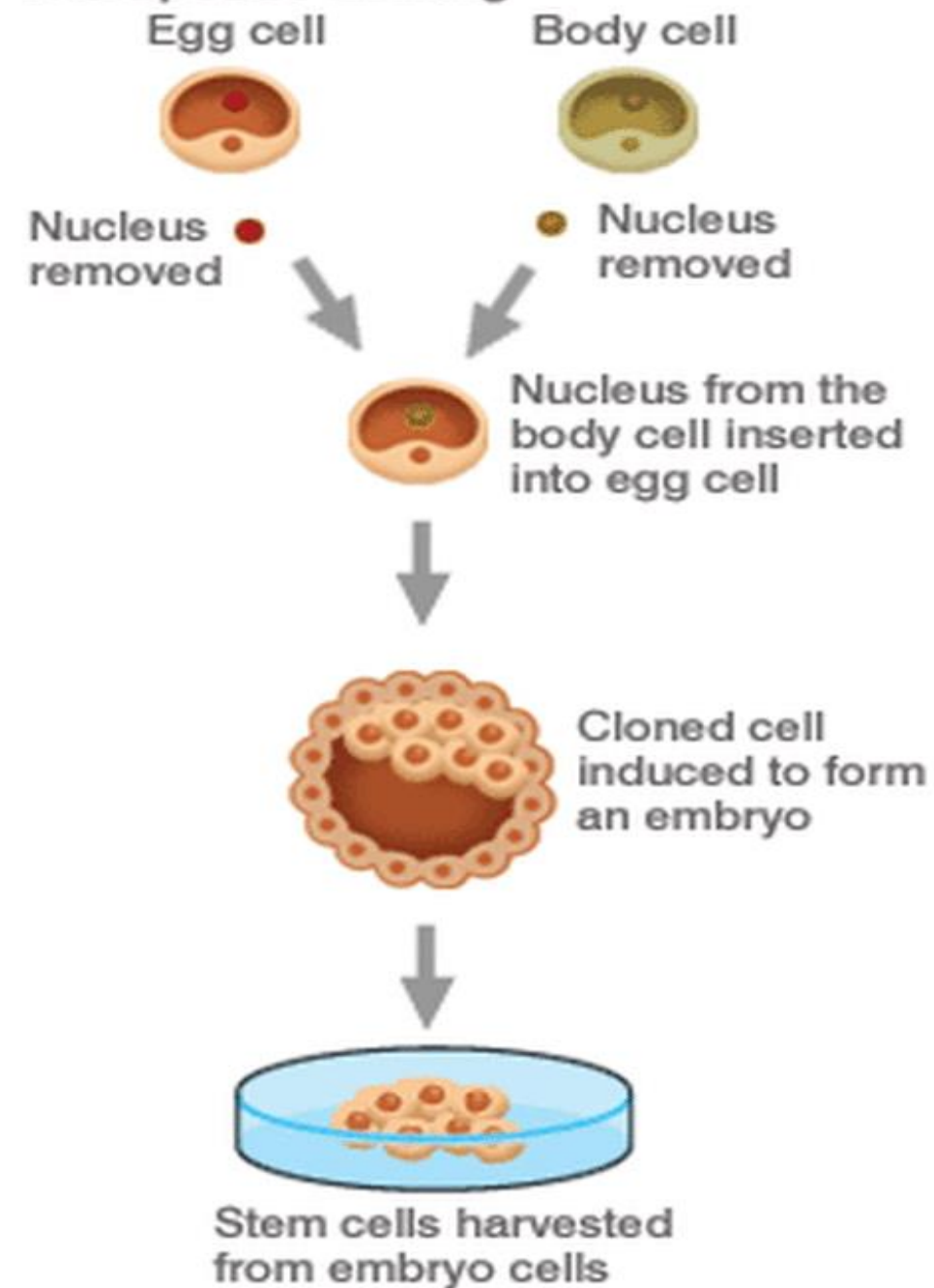




## Therapeutic cloning

- Therapeutic cloning works in a similar way to reproductive cloning.
- A cell is taken from an animal's skin and is inserted into a egg cell.
- Then, the egg is chemically induced so that it creates embryonic stem cells.
- These stem cells can be harvested and used in experiments aimed at understanding diseases and developing new treatments.

## Therapeutic cloning



# ➤ HISTORY OF CLONING

## HISTORY OF CLONING

Some key dates in the history of cloning – inserting genetic material of animal into an egg cell to reproduce a “copy” of the animal:



**1952:** First cloning experiment with frogs; attempt fails

**1970:** Cloned frog embryos develop into tadpoles and then die

**1984:** Lamb born; cloned from immature sheep embryo cells

**1994:** Calves born; cloned from embryos that had grown to at least 120 cells

**1997:** Birth of Dolly the sheep announced, first clone of a mammal using adult cells; another cloned sheep, Polly, genetically altered to contain human gene

**1998:** Fifty mice cloned in three generations from a single mouse

**1999:** Three goats cloned, genetically altered to make protein in milk to treat heart attacks, strokes

**2000:** Pigs cloned for potential use in human organ transplantation

**2001:** Human embryos cloned; never grew bigger than six cells

**2002:** Clonaid says it has cloned the first human — a claim considered to be a hoax

**2004:** Korean team clones first human embryo and extracts stem cells from it



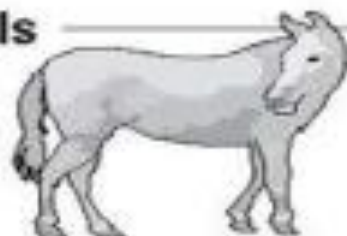
# THE FRUIT OF CLONING'S LABOR

Since the birth of Dolly the sheep, scientists have made strides in animal cloning. The process introduces DNA from an adult cell into an unfertilized egg. More than a dozen animal species have been successfully cloned.

## Cloned from fetal cells



**Rat**  
2003  
National Institute of  
Agricultural Research,  
France



**Mule**  
May, 2003  
Idaho Gem  
University of Idaho

## Cloned from adult mammals



**Sheep**  
July, 1996  
**Dolly**  
Roslin  
Institute,  
Scotland



**Mouse**  
October,  
1997  
**Cumulina**  
University  
of Hawaii



**Cow**  
July, 1998  
**Noto and  
Kaga**  
Three  
Japanese  
institutions



**Goat**  
October, 1998  
**Mira**  
Genzyme  
Transgenics  
Corp.; Tufts  
University



**Pig**  
March, 2000  
**Millie Christa,  
Alexis, Carrel  
and Dotcom**  
PPL  
Therapeutics,  
Scotland



**Mouflon**  
October,  
2000  
**Ombretta**  
University  
of Teramo,  
Italy; Roslin  
Institute,  
Scotland



**Gaur**  
January, 2001  
**Noah**  
Advanced Cell  
Technology



**Cat**  
December,  
2001  
**cc (for  
"carbon  
copy")**  
Texas A&M  
University



**Banteng**  
April, 2003  
**Trans Ova**  
Genetics; ACT;  
Zoological  
Society of San  
Diego



**Horse**  
May, 2003  
**Prometea**  
Laboratory of  
Reproductive  
Technology,  
Italy

**Rabbit**  
2001  
National Institute of Agriculture  
Research, France