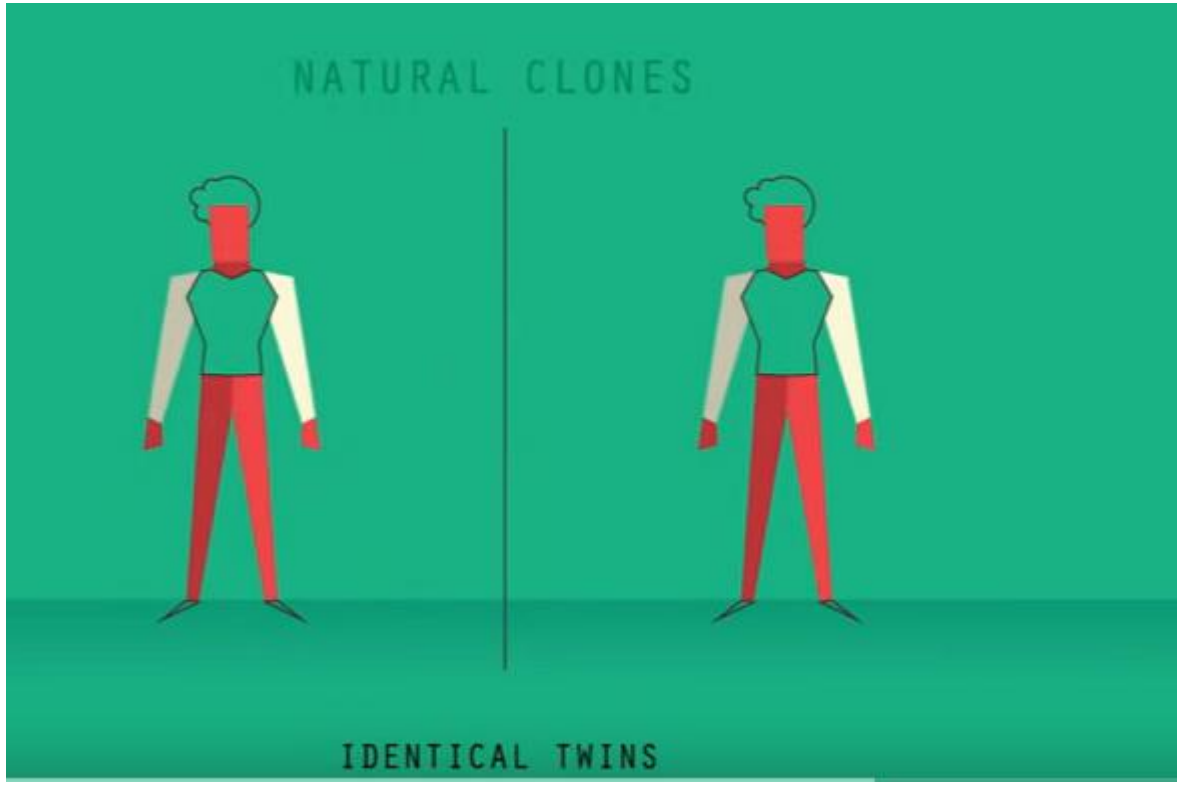
Cloning

What is cloning

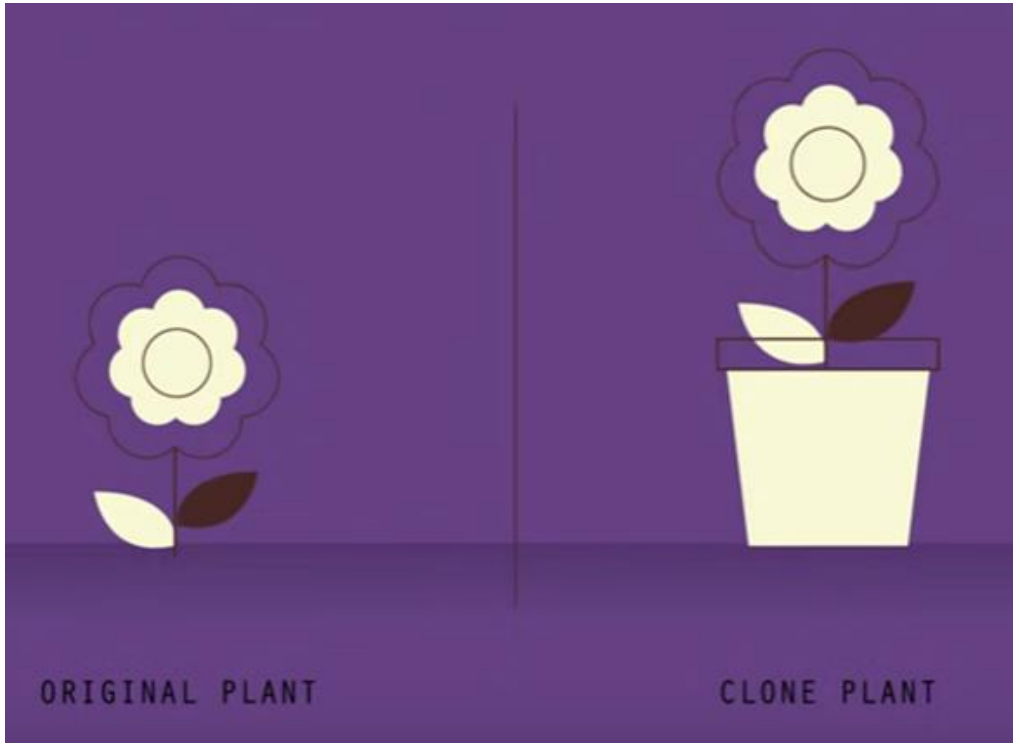
- Cloning is the process of taking genetic information from one living thing and creating identical copies of it.
- The term cloning describes a number of different processes that can be used to produce genetically identical copies of a biological entity.
- The copied material is called a clone.
- Clones 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.

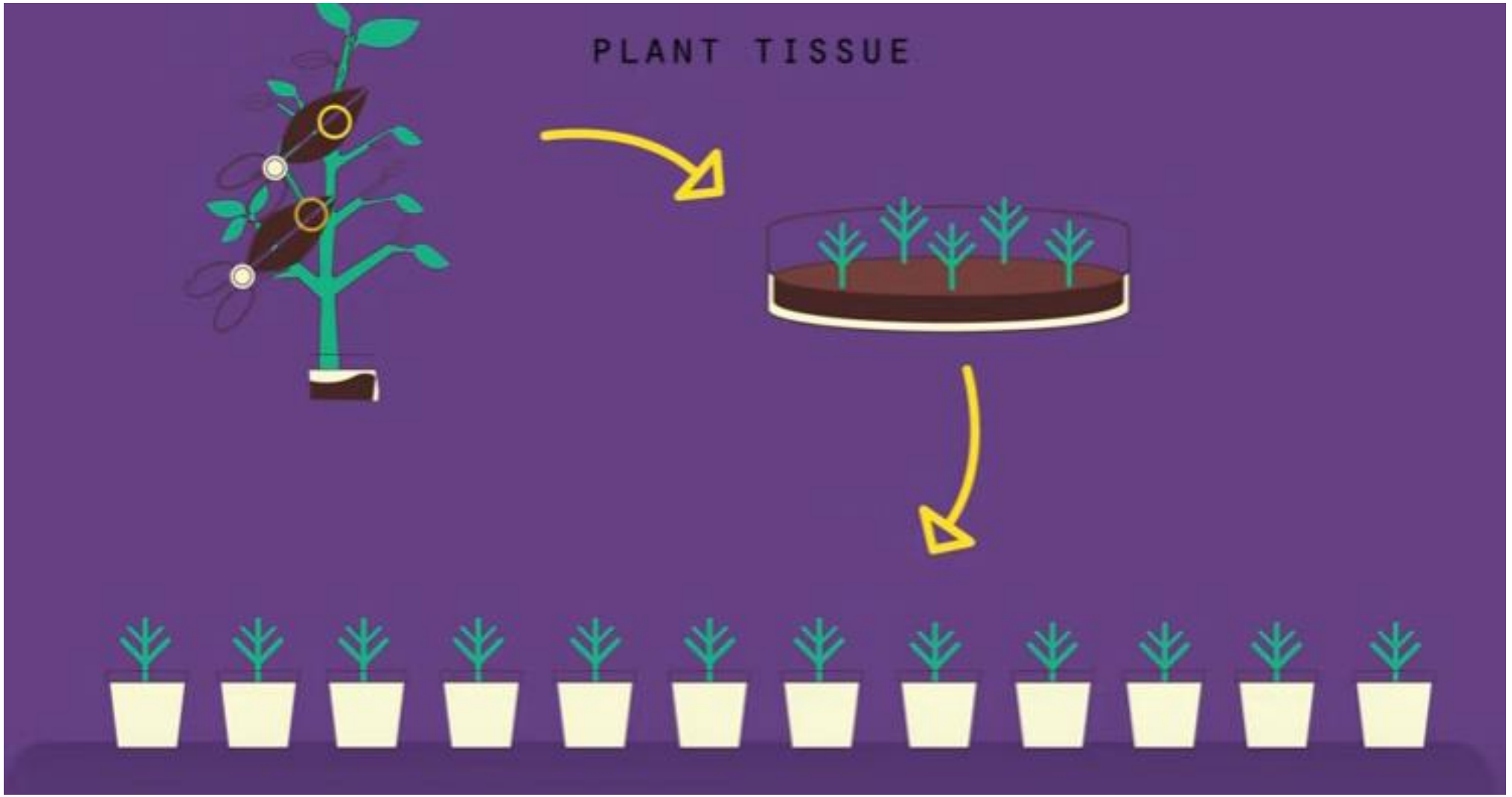
- Nature has been doing the cloning for millions of years.
- For example;

- identical twins have almost identical DNA



- asexual reproduction in some plants and organisms can produce genetically identical offspring




PLANT TISSUE

- 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:
Types of artificial 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

Reproductive cloning

Somatic Cell Nuclear Transfer

Somatic cell nuclear transfer (SCNT), also called nuclear transfer produces 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:

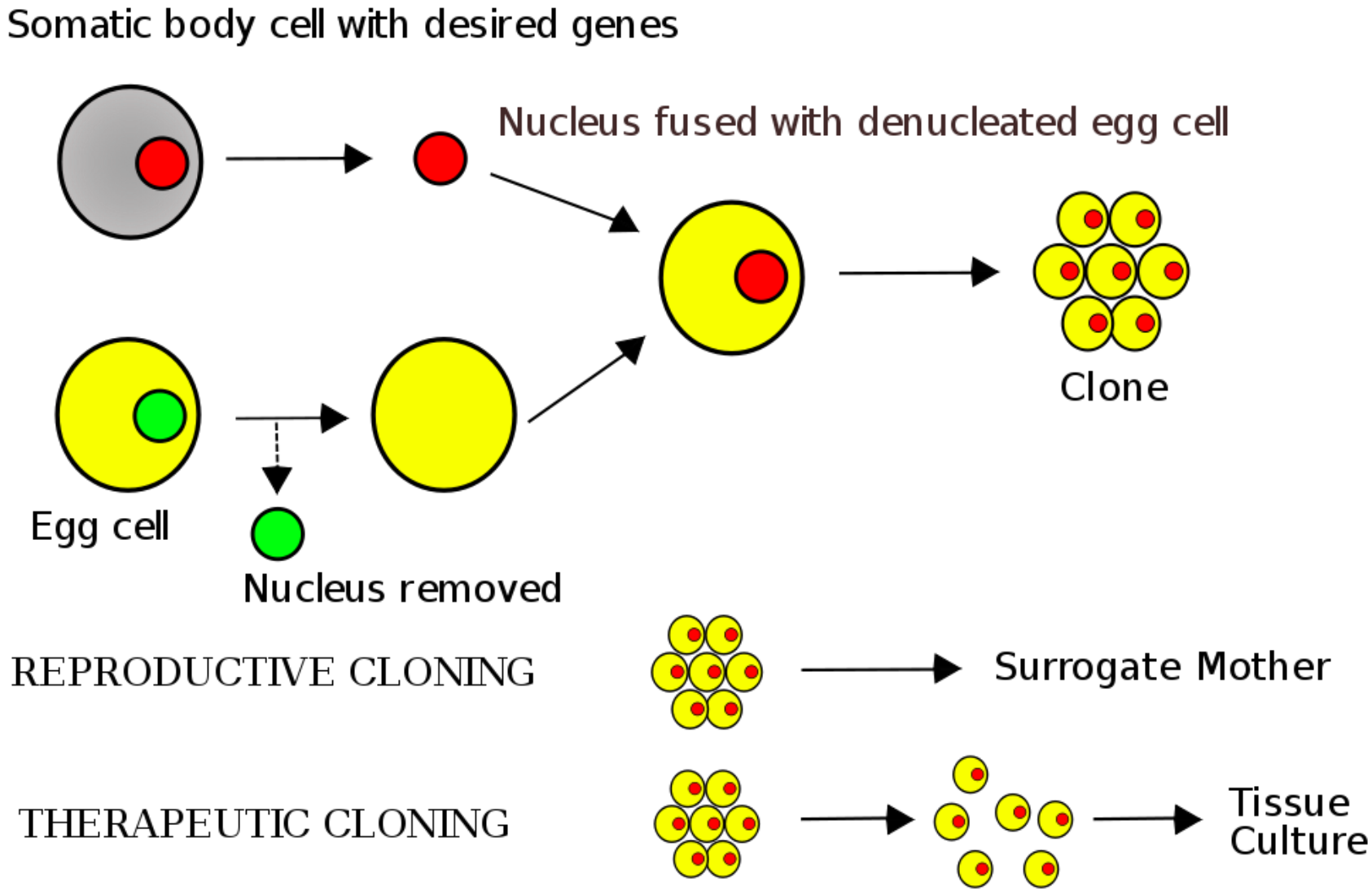
- The nucleus is a compartment that holds the cell's DNA.
- A chromosome is the highest organized structure of DNA double helix with proteins.
- The DNA is divided into packages called chromosomes, and it contains all the information needed to form an organism.
- It's small differences in our DNA that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

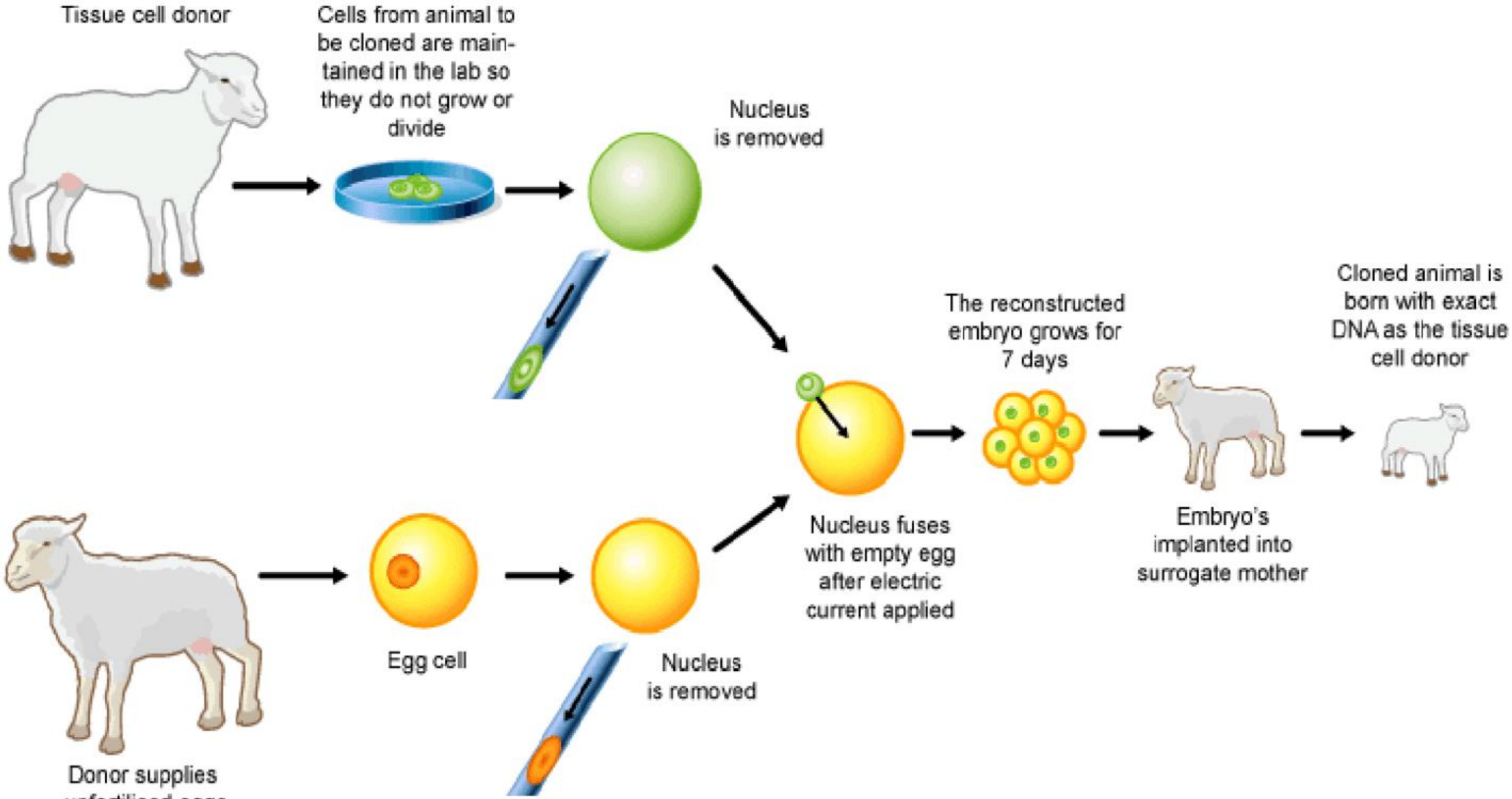
Transfer

- 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

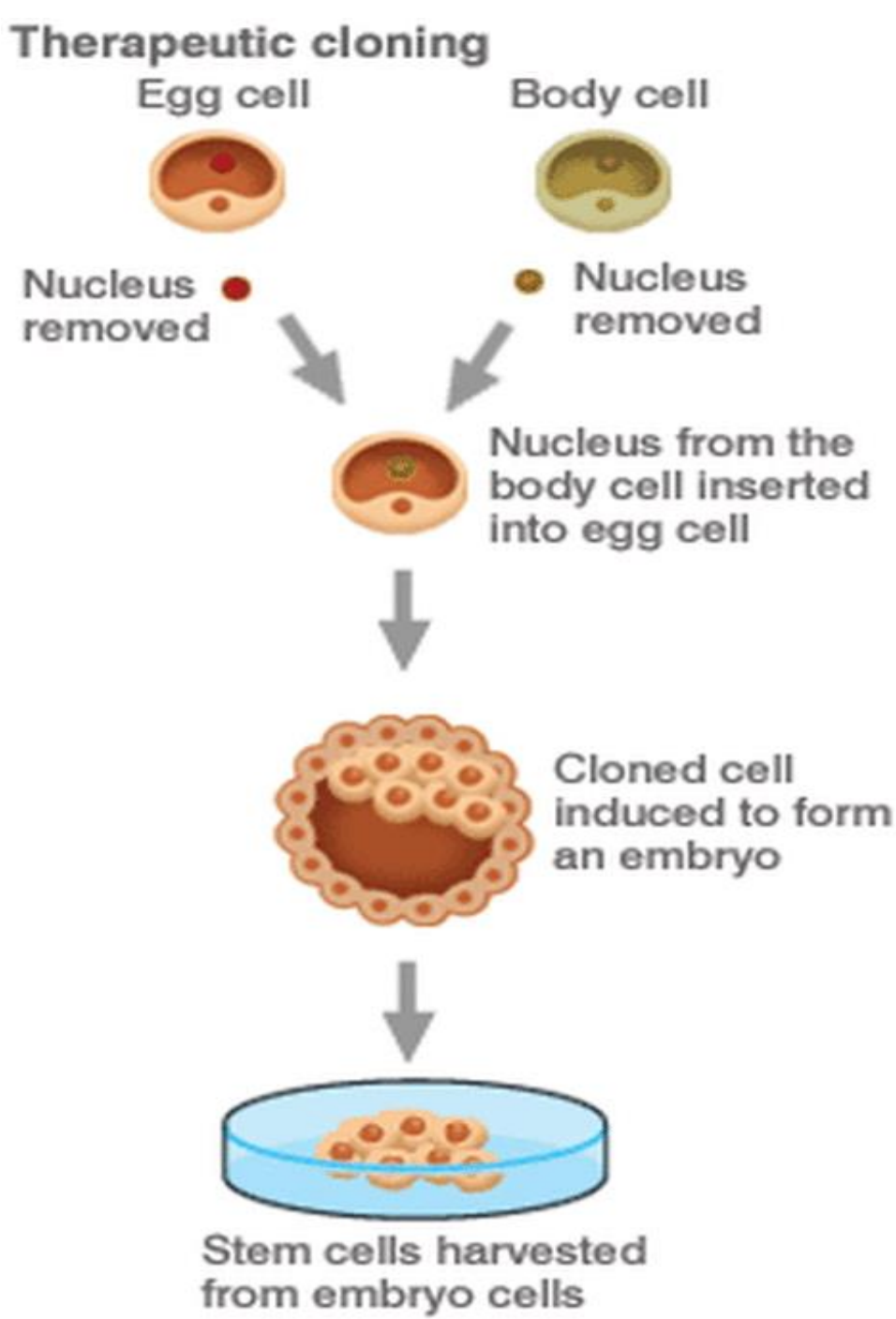
- The adult female gives birth to an animal that has the same genetic make up as the animal that donated the somatic cell.
- This young animal is referred to as a clone.
- Reproductive cloning may require the use of a surrogate mother to allow development of the cloned embryo, as was the case for the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


Somatic body cell with desired genes
Nucleus fused with denucleated egg cell
Clone
Egg cell
Nucleus removed
REPRODUCTIVE CLONING
Surrogate Mother
THERAPEUTIC CLONING
Tissue
Culture


Tissue cell donor
Cells from animal to be cloned are maintained in the lab so they do not grow or divide
Nucleus is removed
The reconstructed embryo grows for 7 days
Cloned animal is born with exact DNA as the tissue cell donor
Nucleus fuses with empty egg after electric current applied
Embryo's implanted into surrogate mother
Egg cell
Nucleus is removed
Donor supplies unfertilised eggs

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
Egg cell
Body cell
Nucleus removed
Nucleus removed
Nucleus from the body cell inserted into egg cell
Cloned cell induced to form an embryo
Stem cells harvested from embryo cells

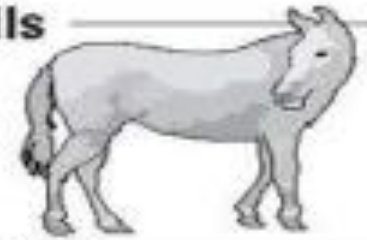
HISTORY OF CLONING

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

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

Gaur
January, 2001
Noah
Advanced Cell Technology

Rabbit
2001
National Institute of Agriculture Research, France

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