

**Cloning:**

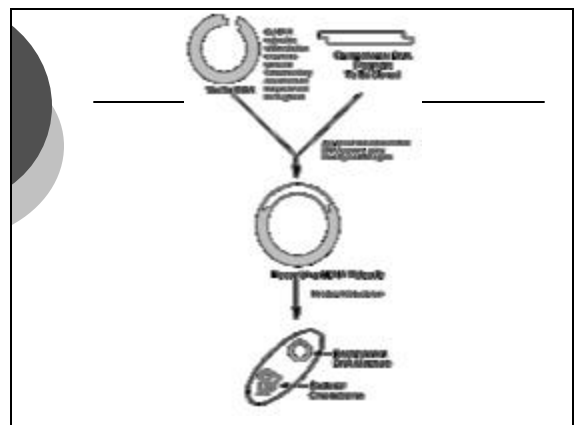
- The term cloning describes a number of different processes that can be used to produce genetically identical copies of a biological entity.
- The copied material, which has the same genetic makeup as the original, is referred to as a clone.
- Source: NHGRI

**The types of artificial cloning?**

- Most people think there is only one type, but there are three different types of artificial cloning.
  - **Gene cloning:** Gene cloning produces copies of genes or segments of DNA.
    - a.k.a.: DNA cloning
  - **Reproductive cloning:** Reproductive cloning produces copies of whole animals.
    - a.k.a. Nuclear Transfer Cloning
  - **Therapeutic cloning:** Therapeutic cloning produces embryonic stem cells for experiments aimed at creating tissues to replace injured or diseased tissues.
    - a.k.a.: Embryonic Cloning

**Gene Cloning**

- The gene of interest is isolated from chromosomal DNA using restriction enzymes.
- Insert the gene from one organism, often referred to as "foreign DNA," into the genetic material of a carrier called a vector.
  - Examples of vectors include bacteria, yeast cells, viruses or plasmids, which are small DNA circles carried by bacteria.
- After the gene is inserted, the vector is placed in laboratory conditions that prompt it to multiply, resulting in the gene being copied many times over.

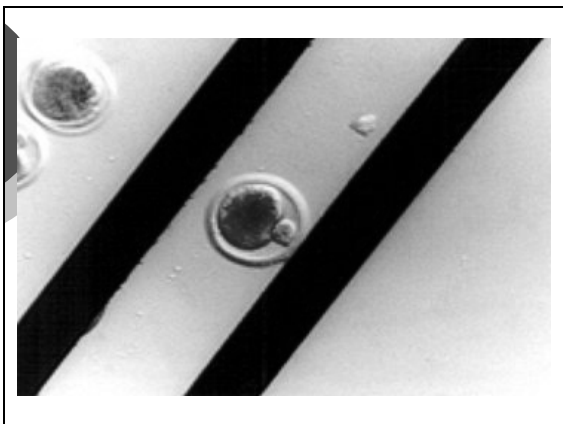
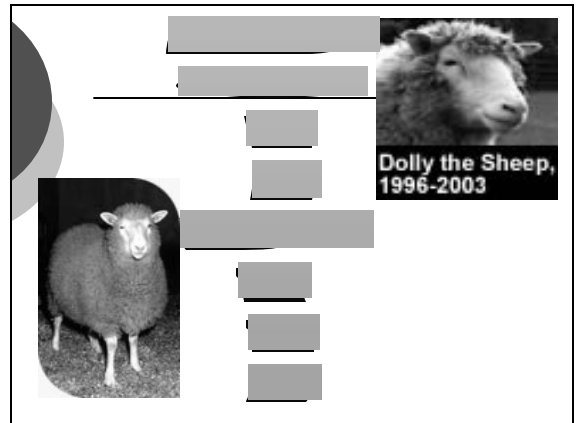
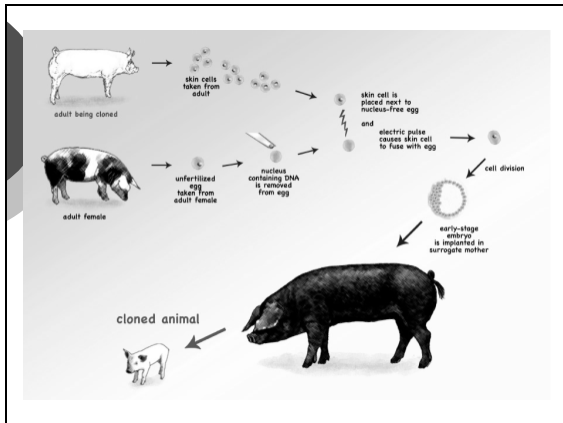


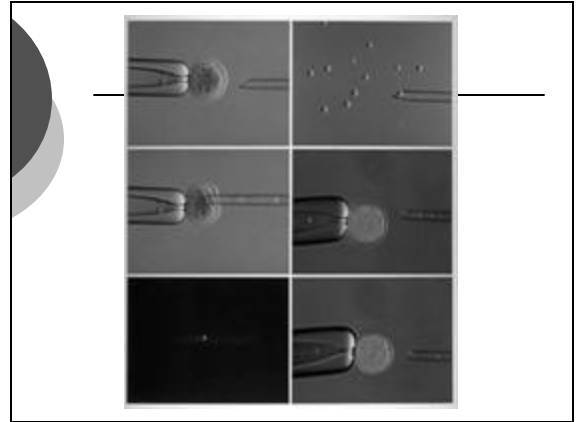
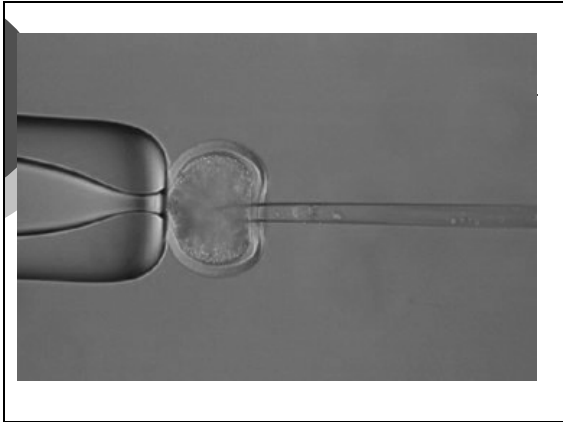
## Reproductive cloning

- Remove a mature somatic cell from an animal that you intend to clone.
- Transfer the DNA of the donor animal's somatic cell into an egg cell, or oocyte, that has had its own DNA-containing nucleus removed.
- Add the DNA from the somatic cell to the empty egg.
  - Two different ways.
    - In the first method, they remove the DNA-containing nucleus of the somatic cell and inject it into the empty egg.
      - The needle is 2/10,000th of an inch wide.
    - In the second approach, they use an electrical current to fuse the entire somatic cell with the empty egg.

## Reproductive cloning cont...

- 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.
  - To stimulate them to begin dividing, either insertion of the chemical ionomycin or electrical pulses are provided.
- The adult surrogate 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.



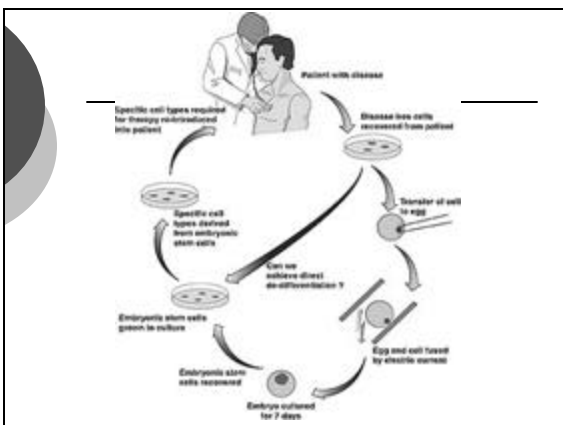


## Therapeutic cloning

- This type of cloning involves creating a cloned embryo to produce embryonic stem cells with the same DNA as the donor cell.
- These stem cells can be used in experiments aimed at understanding disease and developing new treatments for disease.
- The best source of embryonic stem cells is tissue formed during the first five days after the egg has started to divide.
  - At this stage of development, called the blastocyst, the embryo consists of a cluster of about 100 cells
  - These cells can become any cell type as they are still undifferentiated.
  - Stem cells are harvested from cloned embryos at this stage of development, resulting in destruction of the embryo while it is still in the test tube.

## Therapeutic cloning cont...

- This is the most controversial types of cloning.
- Why use Therapeutic cloning?
  - It can be used to grow healthy tissue to replace injured or diseased tissues.
  - It may be possible to learn more about the molecular causes of disease by studying embryonic stem cell lines from cloned embryos from the cells of animals or humans with different diseases.



## A Short Timeline...

- 1901, newt embryo split
- 1914, first nuclear transfer
- 1952, first animal-Leopard Frog tadpole cloned
- 1979, split a mouse embryo
- 1996, First mammal from adult cells is cloned: "Dolly" after 276 attempts
- 1997, "Polly", cloned from skin cells grown in a lab and genetically altered to contain a human gene.